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TMDLs for Fecal Coliform Bacteria, Chlorides, Sulfates, Total Dissolved Solids (TDS), Sediment, Total Suspended Solids (TSS), and Turbidity for Selected Subsegments in the Terrebonne River Basin, Louisiana

(120101, 120102, 120104, 120105, 120106, 120109, 120110, 120111, 120112, 120201, 120206, 120301, 120502, 120503, 120504, 120506, 120507, 120508, 120602, 120605, 120606, 120701, 120703, 120707, 120708)

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EXECUTIVE SUMMARY

Section 303(d) of the Clean Water Act and the U.S. Environmental Protection Agency's (EPA) Water Quality Planning and Management Regulations (Title 40 of the *Code of Federal Regulations* [CFR] Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for impaired waterbodies. A TMDL establishes the amount of a pollutant that a waterbody can assimilate without exceeding its water quality standard for that pollutant. TMDLs provide the scientific basis for a state to establish water quality-based controls to reduce pollution from both point and nonpoint sources to restore and maintain the quality of the state's water resources (USEPA 1991).

A TMDL for a given pollutant and waterbody is composed of the sum of individual wasteload allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources and natural background levels. In addition, the TMDL must include an implicit or explicit margin of safety (MOS) to account for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody and may include a future growth (FG) component. The TMDL components are illustrated using the following equation:

$$TMDL = \sum WLAs + \sum LAs + MOS + FG$$

The study area for this TMDL is the Terrebonne River Basin, which is in southeastern Louisiana. The Terrebonne River Basin covers an area extending approximately 120 miles west of the Mississippi River at Baton Rouge in the north to the Gulf of Mexico in the south. It varies in width from 18 miles to 70 miles. The basin is bounded on the west by the Atchafalaya River Basin and on the east by the Mississippi River and Bayou LaFourche. The topography of the entire basin is lowland, and all the land is subject to flooding except the natural levees along major waterways. The coastal portion of the basin is prone to tidal flooding and consists of marshes ranging from fresh to saline (LDEQ 1993).

The northern portion of the Terrebonne River Basin is dominated by agricultural land and wetlands. The majority of the agricultural land is in sugarcane production. There are also some larger urban areas in two of the subsegments. The lower portion of the Terrebonne River Basin is dominated by wetlands, while some subsegments have large areas of cropland.

The Louisiana Department of Environmental Quality (LDEQ) listed 25 subsegments in the Terrebonne River Basin on Louisiana's 2004 section 303(d) list for various impairments (Table ES-1). The impaired designated uses for the 25 subsegments are primary contact recreation, secondary contact recreation, fish and wildlife propagation, and shellfish (oyster) propagation. The pollutants causing these impairments include fecal coliform bacteria, chloride, sulfate, total dissolved solids (TDS), sediment, total suspended solids (TSS), and turbidity.

The numeric water quality criteria that apply to the impaired subsegments in the Terrebonne River Basin and that were used to calculate the total allowable loads are presented in Table ES-2.

Table ES-1. Section 303(d) listing information for subsegments included in this report

Subseg. number	Subseg. name	Impaired use[a]	Causes of impairment: Chloride	Sulfate	TDS	Sediment	TSS	Turbidity	Fecal coliforms	Suspected sources of impairment
120101	Bayou Portage	PCR, SCR, FWP	X		X		X		X	Irrigated and nonirrigated crop production (chloride, TDS), on-site treatment systems (fecal coliforms), source unknown (TSS)
120102	Bayou Poydras	PCR, FWP		X	X	X	X		X	Source unknown (TSS, sed.), drainage filling, loss of wetland (sulfates, TDS), on-site treatment systems (fecal coliforms)
120104	Bayou Grosse Tete	PCR, FWP			X				X	Irrigated and nonirrigated crop production (TDS), on-site treatment systems (fecal coliforms)
120105	Chamberlin Canal	PCR, SCR, FWP				X	X		X	Source unknown (sed., TSS), on-site treatment systems (fecal coliforms)
120106	Bayou Plaquemine	FWP						X		Source unknown
120109	Intracoastal Waterway	PCR, FWP							X	On-site treatment systems
120110	Bayou Cholpe	FWP		X	X					Irrigated and nonirrigated crop production, drought related impacts
120111	Bayou Maringouin	PCR, SCR, FWP			X				X	Irrigated and nonirrigated crop production (TDS), on-site treatment systems (fecal coliforms)
120112	Bayou Fordoche	PCR, SCR, FWP			X				X	Irrigated and nonirrigated crop production and drought-related impacts (TDS), on-site treatment systems (fecal coliforms)
120201	Lower Grand River and Belle River	PCR, FWP		X					X	Drought related, petroleum/natural gas activities (sulfates), on-site treatment systems (fecal coliforms)
120206	Grand Bayou and Little Grand Bayou-	PCR, SCR, FWP							X	Municipal point source discharges, on-site treatment systems
120301	Bayou Terrebonne	PCR, FWP							X	Municipal, on-site treatment systems, package plant or other permitted small-flow discharges, sanitary sewer overflows
120502	Bayou Grand Caillou	SFP							X	On-site treatment systems, package plant or other permitted small-flow discharges, industrial point source discharges, total retention domestic sewage lagoons, marina/boating sanitary on-vessel discharges
120503	Bayou Petit Caillou	FWP, SFP							X	On-site treatment systems, package plant or other permitted small-flow discharges, total retention domestic sewage lagoons
120504	Bayou Petit Caillou	PCR, SCR, FWP, SFP							X	On-site treatment systems, package plant or other permitted small-flow discharges, total retention domestic sewage lagoons
120506	Bayou du Large	FWP, SFP							X	On-site treatment systems, package plant or other permitted small-flow discharges, total retention domestic sewage lagoons

Table ES-1. (continued)

Subseg. number	Subseg. name	Impaired use[a]	Causes of impairment: Chloride	Sulfate	TDS	Sediment	TSS	Turbidity	Fecal coliforms	Suspected sources of impairment
120101	Bayou Portage	PCR, SCR, FWP	X		X		X		X	Irrigated and nonirrigated crop production (chloride, TDS), on-site treatment systems (fecal coliforms), source unknown (TSS)
120507	Bayou Chauvin	PCR, SCR, FWP							X	Municipal, total retention domestic sewage lagoons, package plant or other permitted small-flow discharges, sanitary sewer overflows
120508	Houma Navigation Canal	SFP							X	Source unknown
120602	Bayou Terrebonne	FWP, SFP							X	Municipal, Municipal point source, marina/boating on-vessel discharges, package plant or other small-flow discharges, total retention domestic sewage
120605	Bayou Pointe au Chien	PCR, FWP							X	On-site treatment systems, package plant or other permitted small-flow discharges, total retention domestic sewage lagoons, wildlife other than waterfowl
120606	Bayou Blue	PCR, FWP							X	On-site treatment systems, package plant or other permitted small-flow discharges
120701	Bayou Grand Caillou	SFP							X	Source unknown
120703	Bayou du Large	FWP, SFP							X	On-site treatment systems, package plant or other permitted small-flow discharges, marina/boating on-vessel discharges
120707	Lake Boudreaux	FWP, SFP							X	On-site treatment systems, package plant or other permitted small-flow discharges, total retention domestic sewage lagoon
120708	Lost Lake, Four League Bay	SFP							X	Marina/boating sanitary on-vessel discharging, wildlife other than waterfowl

[a]PCR = primary contact recreation; SCR = secondary contact recreation; FWP = fish and wildlife propagation; SFP = shellfish/oyster propagation.
Source: LDEQ 2005a.

Table ES-2. Numeric water quality criteria for the listed subsegments

Subsegment number	Subsegment name	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)	Sediment[a] (mg/L)	TSS[a] (mg/L)	Turbidity (NTU)	Bacteria[b] (colonies/100 mL)
120101	Bayou Portage	25		200		X		400 (5/01–10/31) 2,000 (11/01–4/30)
120102	Bayou Poydras		75	500	X	X		400 (5/01–10/31) 2,000 (11/01–4/30)
120104	Bayou Grosse Tete			200				400 (5/01–10/31) 2,000 (11/01–4/30)
120105	Chamberlin Canal				X	X		400 (5/01–10/31) 2,000 (11/01–4/30)

Table ES-2. (continued)

Subsegment number	Subsegment name	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)	Sediment[a] (mg/L)	TSS[a] (mg/L)	Turbidity (NTU)	Bacteria[b] (colonies/100 mL)
120106	Bayou Plaquemine						150	
120109	Intracoastal Waterway							400 (5/01–10/31) 2,000 (11/01–4/30)
120110	Bayou Cholpe		25	200				
120111	Bayou Maringouin			200				400 (5/01–10/31) 2,000 (11/01–4/30)
120112	Bayou Fordoche			200				400 (5/01–10/31) 2,000 (11/01–4/30)
120201	Lower Grand River and Belle River		40					400 (5/01–10/31) 2,000 (11/01–4/30)
120206	Grand Bayou and Little Grand Bayou							400 (5/01–10/31) 2,000 (11/01–4/30)
120301	Bayou Terrebonne							400 (5/01–10/31) 2,000 (11/01–4/30)
120502	Bayou Grand Caillou							14 (median) 43 (10%)
120503	Bayou Petit Caillou							14 (median) 43 (10%)
120504	Bayou Petit Caillou							14 (median) 43 (10%)
120506	Bayou du Large							14 (median) 43 (10%)
120507	Bayou Chauvin							400 (5/01–10/31) 2,000 (11/01–4/30)
120508	Houma Navigation Canal							14 (median) 43 (10%)
120602	Bayou Terrebonne							14 (median) 43 (10%)
120605	Bayou Pointe au Chien							400 (5/01–10/31) 2,000 (11/01–4/30)
120606	Bayou Blue							400 (5/01–10/31) 2,000 (11/01–4/30)
120701	Bayou Grand Caillou							14 (median) 43 (10%)
120703	Bayou du Large							14 (median) 43 (10%)
120707	Lake Boudreaux							14 (median) 43 (10%)
120708	Lost Lake, Four League Bay							14 (median) 43 (10%)

[a] No sediment or TSS criteria have been defined in the Louisiana Water Quality Standards. TMDL endpoints were determined through a relationship between TSS and turbidity.

[b] Criteria for primary and secondary contact recreation apply. Primary contact recreation: No more than 25 percent of the total samples collected on a monthly basis shall exceed a fecal coliform bacteria density of 400 colonies/100 mL. Shall apply only during the defined recreational period of 05/01 through 10/31. For all other periods a fecal coliform bacteria density of 2,000 colonies/100 mL for secondary contact recreation applies.

Criteria for oyster propagation. The fecal coliform bacteria median MPN shall not exceed 14 colonies/100 mL, and not more than 10 percent of the samples shall exceed an MPN of 43 colonies/100 mL for a five tube decimal dilution test in those portions of the area most probably exposed to fecal contamination during the most unfavorable hydrographic and pollution conditions.

Source: LDEQ 2005b

Because turbidity cannot be expressed as a mass load, the turbidity TMDL was expressed using TSS as a surrogate for turbidity. Historical water quality data were analyzed for relationships between turbidity and TSS. A regression between turbidity and TSS was developed for subsegment 120106 using turbidity and TSS data from that subsegment, resulting in a surrogate TSS endpoint of 125 mg/L.

Because only narrative criteria are available for TSS, it was necessary to calculate a numerical endpoint for TSS to develop the TMDL for the three subsegments listed for TSS. The TSS endpoint was calculated on the basis of the relationship between turbidity and TSS using the same methodology (regression analysis) used to calculate the surrogate TSS value for turbidity in subsegment 120106. The resulting surrogate endpoints were 290 mg/L, 247 mg/L, and 302 mg/L for subsegments 120101, 120102, and 120105, respectively.

The TMDLs in the Terrebonne River Basin were calculated using a concentration reduction approach. Using this approach the percent reduction for each LDEQ monitoring station was calculated on the basis of observed levels of constituents. The minimum percent reduction was calculated so that the monitoring data would meet criteria at that station. The percent reduction was applied to the entire subsegment. If two monitoring stations were present in a subsegment, the larger percent reduction was used to ensure that both monitoring stations meet criteria.

Because of the lack of flow data in the Terrebonne River Basin, the monthly water yield (runoff in millimeters) was used to obtain TMDL loadings. The water yield was used to determine runoff intensities that were multiplied by each subsegment area and the average reduced constituent levels to obtain the TMDL loading. On the basis of the analyses of water quality criteria, most fecal coliform bacteria TMDLs were developed on a seasonal basis (i.e., calculating allowable loads and percent reductions for both summer and winter). Subsegments with oyster propagation as its designated use had fecal coliform bacteria TMDLs developed to apply year-round, as did the other pollutants (chloride, sulfate, TDS, TSS, and turbidity).

In TMDL development, allowable loadings from all pollutant sources that cumulatively amount to no more than the TMDL must be established and thereby provide the basis for establishing water quality-based controls. WLAs were given to permitted point source discharges, including Phase I and Phase II municipal separate storm sewer systems (MS4s). The LAs include background loadings as well as human-induced nonpoint sources. An explicit MOS of 10 percent and was included, except for turbidity, sediment, and TSS which had an implicit MOS. A FG component of 10 percent is also included in this TMDL.

The reductions for fecal coliform bacteria at the monitoring stations in the Terrebonne River Basin during the summer months range from 20 to 95 percent. Winter reductions range from 0 to 88 percent and annual reductions for the shellfish/oyster propagation areas range from 30 to 98 percent. The chloride-impaired subsegment requires a reduction of 53 percent. The reductions for sulfate range from 44 to 84 percent. TDS reductions range from 32 to 66 percent and 0 to 62 percent for the subsegments listed for sediment, TSS, and turbidity. Summaries of the TMDLs for the subsegments addressed in this report are presented in Tables ES-3, ES-4, and ES-5.

Table ES-3. Summary of fecal coliform bacteria TMDLs, MOS, FG, WLAs, and LAs for the Terrebonne River Basin

Subsegment	Station	Season	Percent reduction	Total allowable loading	Explicit MOS (10%)	Future growth (10%)	∑ WLA	∑ LA
				1×10^9 colonies/day				
120101	968	Summer	92.0	146.48	14.65	14.65	0.00	117.18
120101	968	Winter	87.5	732.70	73.27	73.27	0.00	586.16
120102	969	Summer	20.0	110.37	11.04	11.04	0.00	88.30
120102	969	Winter	0.0	176.64	17.66	17.66	0.00	141.31
120104	970	Summer	64.0	127.53	12.75	12.75	0.00	102.02
120104	970	Winter	0.0	660.00	66.00	66.00	0.00	528.00
120105	971	Summer	92.0	30.99	3.10	3.10	0.00	24.79
120105	971	Winter	0.0	68.96	6.90	6.90	0.00	55.17
120109	80	Summer	20.0	183.45	18.35	18.35	1.54	145.22
120109	80	Winter	0.0	355.97	35.60	35.60	2.99	281.79
120111	977	Summer	86.7	42.77	4.28	4.28	0.00	34.22
120111	977	Winter	0.0	51.24	5.12	5.12	0.00	40.99
120112	978	Summer	64.0	110.64	11.06	11.06	0.00	88.51
120112	978	Winter	16.7	893.61	89.36	89.36	0.00	714.88
120201	979	Summer	20.0	356.63	35.66	35.66	0.95	284.36
120201	979	Winter	0.0	752.72	75.27	75.27	0.95	601.23
120206	82	Summer	20.0	693.55	69.35	69.35	1.16	553.68
120206	82	Winter	0.0	1,993.61	199.36	199.36	1.16	1,593.74
120301	110	Summer	94.94	247.45	24.74	24.74	87.79	110.17
120301	110	Winter	62.96	5,584.35	558.43	558.43	1,973.02	2,494.46
120502	113	Year	96.69	1.34	0.13	0.13	0.00	1.08
120503	939	Year	95.33	0.35	0.04	0.04	0.06	0.23
120504	347	Year	98.21	0.97	0.10	0.10	0.23	0.54
120506	941	Year	91.40	0.69	0.07	0.07	0.00	0.55
120507	345	Summer	20.00	235.32	23.53	23.53	12.04	176.21
120507	345	Winter	0.00	229.95	23.00	23.00	11.77	172.19
120508	344	Year	81.30	3.88	0.39	0.39	0.00	3.11
120602	349	Year	98.21	0.73	0.07	0.07	0.08	0.51
120605	946	Summer	20.00	114.62	11.46	11.46	0.99	90.71
120605	946	Winter	0.00	75.85	7.59	7.59	0.65	60.03
120606	947	Summer	20.00	18.15	1.81	1.81	0.57	13.95
120606	947	Winter	0.00	20.22	2.02	2.02	0.57	15.61
120701	351	Year	30.00	26.99	2.70	2.70	0.00	21.59
120703	350	Year	89.23	18.44	1.84	1.84	0.00	14.76
120707	954	Year	74.71	3.98	0.40	0.40	0.00	3.19
120708	955	Year	81.30	19.90	1.99	1.99	0.00	15.92

Table ES-4. Summary of chloride and sulfate TMDLs, MOS, FG, WLAs, and LAs for the Terrebonne River Basin

Subsegment	Station	Pollutant	Percent reduction	Total allowable loading	Explicit MOS (10%)	Future growth (10%)	∑ WLA	∑ LA
				kg/day				
120101	968	Chloride	53.4	679.7	68.0	68.0	8.3	535.4
120102	969	Sulfate	82.5	417.9	41.8	41.8	0.0	334.3
120110	976	Sulfate	84.1	136.1	13.6	13.6	0.0	108.9
120201	979	Sulfate	44.4	2,485.9	248.6	248.6	14.2	1,974.5

Table ES-5. Summary of TDS, sediment, TSS, and turbidity TMDLs, MOS, FG, WLAs, and LAs for the Terrebonne River Basin

Subsegment	Station	Pollutant	Percent reduction	Total allowable loading	Explicit MOS (10%)	Future growth (10%)	∑ WLA	∑ LA
				tons/day				
120101	968	TDS	66.4	6.50	0.65	0.65	0.00	5.20
120102	969	TDS	43.7	4.04	0.40	0.40	0.00	3.23
120104	970	TDS	32.4	10.31	1.03	1.03	0.00	8.25
120110	976	TDS	55.6	2.17	0.22	0.22	0.00	1.74
120111	977	TDS	63.2	3.31	0.33	0.33	0.00	2.64
120112	978	TDS	43.8	3.37	0.34	0.34	0.00	2.69
120101	968	TSS	62.4	2.48	Implicit	0.25	0.00	2.24
120102	969	Sediment/ TSS	0.0	1.21	Implicit	0.12	0.00	1.09
120105	971	Sediment/ TSS	0.0	2.15	Implicit	0.22	0.00	1.94
120106	972	Turbidity as TSS	0.0	0.07	Implicit	0.01	0.00	0.06

Hurricane Katrina made landfall on Monday, August 29, 2005, as a Category 4 hurricane. The storm brought heavy winds and rain to southeast Louisiana, breaching several levees and flooding up to 80 percent of New Orleans and large areas of coastal Louisiana. Much of the area that was flooded during Hurricane Katrina was flooded again by the storm surge from Hurricane Rita. Both Hurricanes Katrina and Rita have caused a significant amount of change in sedimentation and water quality in southern Louisiana. Many wastewater treatment facilities were temporarily or permanently damaged. Some wastewater treatment facilities will be rebuilt while others will be relocated. The hurricanes expedited the loss of coastal land and modified the hydrology of some of the coastal waterbodies. Several federal and state agencies including EPA and LDEQ are engaged in collecting environmental data and assessing the recovery of the Gulf of Mexico waters. The proposed TMDLs in this report were developed on the basis of pre-hurricane conditions. Therefore, post-hurricane conditions and other factors could delay the implementation of these proposed TMDLs, render some proposed TMDLs obsolete, or could require modifications of the TMDLs.

Much of coastal Louisiana was built by the process of delta formation through flooding and deposition of sediments by the rise and fall of the Mississippi River. According to EPA's present knowledge, extensive areas of wetlands and coastal marshes are affected by a high rate of subsidence and degradation, primarily due to a lack of historical sediment and nutrients entering the wetlands. Subsidence is a natural process, but the building of levee systems has restricted the Mississippi River's course and, therefore, is preventing the natural cycle of the river and the natural process of delta formation. According to EPA, a large portion of the state's coastal wetlands have undergone and continue to undergo severe deprivation of sediments and nutrients that has led to the breakup of the natural system. In addition, EPA believes that many of Louisiana's wetlands have become isolated from the riverine sources that created them and are becoming stagnant and starved for nutrients and organic and inorganic sediments. Note that restoration of these eroding wetlands involves supplying nutrients to these areas through managed Mississippi River diversions.

According to EPA's understanding, if any future diversion from the Mississippi River or other tributaries will increase flow, the nonpoint source load allocation and TMDLs will also be increased proportionately. From EPA's current understanding, the diversion projects are supported by both state and federal agencies, including EPA and the U.S. Army Corps of Engineers (USACE). The diversions are managed by the USACE and the state, and the projects include post-diversion monitoring to determine effectiveness of the project and to monitor water quality conditions.

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FIGURES

1 INTRODUCTION

Section 303(d) of the Clean Water Act and the U.S. Environmental Protection Agency's (EPA) Water Quality Planning and Management Regulations (Title 40 of the *Code of Federal Regulations* [CFR] Part 130) requires states to develop Total Maximum Daily Loads (TMDLs) for waterbodies that are not supporting their designated uses, even if pollutant sources have implemented technology-based controls. A TMDL establishes the maximum allowable load (mass per unit of time) of a pollutant that a waterbody is able to assimilate and still support its designated uses. The maximum allowable load is determined on the basis of the relationship between pollutant sources and in-stream water quality. A TMDL provides the scientific basis for a state to establish water quality-based controls to reduce pollution from both point and nonpoint sources to restore and maintain the quality of the state's water resources (USEPA 1991).

Monitoring data collected by the Louisiana Department of Environmental Quality (LDEQ) indicate that observed water quality data sometimes exceed water quality standards for 25 subsegments in the Terrebonne River Basin. The impaired designated uses for the 25 subsegments are primary contact recreation, secondary contact recreation, fish and wildlife propagation, and shellfish (oyster) propagation. The pollutants causing these impairments include fecal coliform bacteria, chloride, sulfate, total dissolved solids (TDS), sediment, total suspended solids (TSS), and turbidity. Table 1-1 presents information from Louisiana's 2004 section 303(d) list for the 14 subsegments.

Table 1-1. Subsegments and parameters for impairments addressed in this report

Subseg. number	Subseg. name	Impaired use[a]	Causes of impairment							Suspected sources of impairment
			Chloride	Sulfate	TDS	Sediment	TSS	Turbidity	Fecal coliforms	
120101	Bayou Portage	PCR, SCR, FWP	X		X		X		X	Irrigated and nonirrigated crop production (chloride, TDS), on-site treatment systems (fecal coliforms), source unknown (TSS)
120102	Bayou Poydras	PCR, FWP		X	X	X	X		X	Source unknown (TSS, sed.), drainage filling, loss of wetland (sulfates, TDS), on-site treatment systems (fecal coliforms)
120104	Bayou Grosse Tete	PCR, FWP			X				X	Irrigated and nonirrigated crop production (TDS), on-site treatment systems (fecal coliforms)
120105	Chamberlin Canal	PCR, SCR, FWP				X	X		X	Source unknown (sed., TSS), on-site treatment systems (fecal coliforms)
120106	Bayou Plaquemine	FWP						X		Source unknown
120109	Intracoastal Waterway	PCR, FWP							X	On-site treatment systems
120110	Bayou Cholpe	FWP		X	X					Irrigated and nonirrigated crop production, drought related impacts
120111	Bayou Maringouin	PCR, SCR, FWP			X				X	Irrigated and nonirrigated crop production (TDS), on-site treatment systems (fecal coliforms)

Table 1-1. (continued)

Subseg. number	Subseg. name	Impaired use[a]	Causes of impairment							Suspected sources of impairment
			Chloride	Sulfate	TDS	Sediment	TSS	Turbidity	Fecal coliforms	
120112	Bayou Fordoche	PCR, SCR, FWP			X				X	Irrigated and nonirrigated crop production and drought-related impacts (TDS), on-site treatment systems (fecal coliforms)
120201	Lower Grand River and Belle River	PCR, FWP		X					X	Drought related, petroleum/natural gas activities (sulfates), on-site treatment systems (fecal coliforms)
120206	Grand Bayou and Little Grand Bayou-	PCR, SCR, FWP							X	Municipal point source discharges, on-site treatment systems
120301	Bayou Terrebonne	PCR, FWP							X	Municipal, on-site treatment systems, package plant or other permitted small-flow discharges, sanitary sewer overflows
120502	Bayou Grand Caillou	SFP							X	On-site treatment systems, package plant or other permitted small-flow discharges, industrial point source discharges, total retention domestic sewage lagoons, marina/boating sanitary on-vessel discharges
120503	Bayou Petit Caillou	FWP, SFP							X	On-site treatment systems, package plant or other permitted small-flow discharges, total retention domestic sewage lagoons
120504	Bayou Petit Caillou	PCR, SCR, FWP, SFP							X	On-site treatment systems, package plant or other permitted small-flow discharges, total retention domestic sewage lagoons
120506	Bayou du Large	FWP, SFP							X	On-site treatment systems, package plant or other permitted small-flow discharges, total retention domestic sewage lagoons
120507	Bayou Chauvin	PCR, SCR, FWP							X	Municipal, total retention domestic sewage lagoons, package plant or other permitted small-flow discharges, sanitary sewer overflows
120508	Houma Navigation Canal	SFP							X	Source unknown
120602	Bayou Terrebonne	FWP, SFP							X	Municipal, Municipal point source, marina/boating on-vessel discharges, package plant or other small-flow discharges, total retention domestic sewage
120605	Bayou Pointe au Chien	PCR, FWP							X	On-site treatment systems, package plant or other permitted small-flow discharges, total retention domestic sewage lagoons, wildlife other than waterfowl
120606	Bayou Blue	PCR, FWP							X	On-site treatment systems, package plant or other permitted small-flow discharges
120701	Bayou Grand Caillou	SFP							X	Source unknown

Table 1-1. (continued)

Subseg. number	Subseg. name	Impaired use[a]	Causes of impairment							Suspected sources of impairment
			Chloride	Sulfate	TDS	Sediment	TSS	Turbidity	Fecal coliforms	
120703	Bayou du Large	FWP, SFP							X	On-site treatment systems, package plant or other permitted small-flow discharges, marina/boating on-vessel discharges
120707	Lake Boudreaux	FWP, SFP							X	On-site treatment systems, package plant or other permitted small-flow discharges, total retention domestic sewage lagoon
120708	Lost Lake, Four League Bay	SFP							X	Marina/boating sanitary on-vessel discharging, wildlife other than waterfowl

[a]PCR = primary contact recreation; SCR = secondary contact recreation; FWP = fish and wildlife propagation; SFP = shellfish/oyster propagation.
Source: LDEQ 2005a.

2 BACKGROUND INFORMATION

2.1 General Description

The 25 subsegments addressed in this TMDL report are in the Terrebonne River Basin, which is in southeastern Louisiana in portions of U.S. Geological Survey (USGS) hydrologic unit codes (HUCs) 08070300 and 08090302. Figures 2-1 and 2-2 show the locations of the listed subsegments in the upper and lower portions of the Terrebonne River Basin, respectively. The subsegments are in portions of 10 parishes. The Terrebonne River Basin covers an area extending approximately 120 miles west of the Mississippi River at Baton Rouge in the north to the Gulf of Mexico in the south. It varies in width from 18 miles to 70 miles. The basin is bounded on the west by the Atchafalaya River Basin and on the east by the Mississippi River and Bayou LaFourche. The topography of the entire basin is lowland, and all the land is subject to flooding except the natural levees along major waterways. The coastal portion of the basin is prone to tidal flooding and consists of marshes ranging from fresh to saline (LDEQ 1993). Table 2-1 lists the parishes in which the subsegments are located and the drainage area of each subsegment.

Table 2-1. Parish and drainage area for each listed subsegment in the Terrebonne River Basin

Segment number	Segment name	Parish	Drainage area (acres)
120101	Bayou Portage	Pointe Coupee	5,493.6
120102	Bayou Poydras	Pointe Coupee, West Baton Rouge	1,293.6
120104	Bayou Grosse Tete	Pointe Coupee, Iberville, West Baton Rouge	6,319.2
120105	Chamberlin Canal	Pointe Coupee, West Baton Rouge	2,447.4
120106	Bayou Plaquemine	Iberville	148.2
120109	Intracoastal Waterway	Iberville, West Baton Rouge	3,804.6
120110	Bayou Cholpe	Pointe Coupee, West Baton Rouge	1,457.3
120111	Bayou Maringouin	Pointe Coupee, Iberville	3,012.6
120112	Bayou Fordoche	Pointe Coupee	2,436.6
120201	Lower Grand River and Belle River	Iberville, Iberia, Assumption, St. Martin, St. Mary	10,700.5
120206	Grand Bayou and Little Grand Bayou	Iberville, Ascension, Assumption	9,329.6
120301	Bayou Terrebonne	LaFourche, Terrebonne	3,279.3
120502	Bayou Grand Caillou	Terrebonne	1,089.4
120503	Bayou Petit Caillou	Terrebonne	290.0
120504	Bayou Petit Caillou	Terrebonne	876.5
120506	Bayou du Large	Terrebonne	436.9
120507	Bayou Chauvin	Terrebonne	2,595.3
120508	Houma Navigation Canal	Terrebonne	1,758.3
120602	Bayou Terrebonne	Terrebonne	476.7
120605	Bayou Pointe au Chien	LaFourche, Terrebonne	2,601.5
120606	Bayou Blue	LaFourche	1,116.0
120701	Bayou Grand Caillou	Terrebonne	9,681.6

Table 2-1. (continued)

Segment number	Segment name	Parish	Drainage area (acres)
120703	Bayou du Large	Terrebonne	6,026.1
120707	Lake Boudreaux	Terrebonne	1,849.5
120708	Lost Lake, Four League Bay	Terrebonne	11,274.2

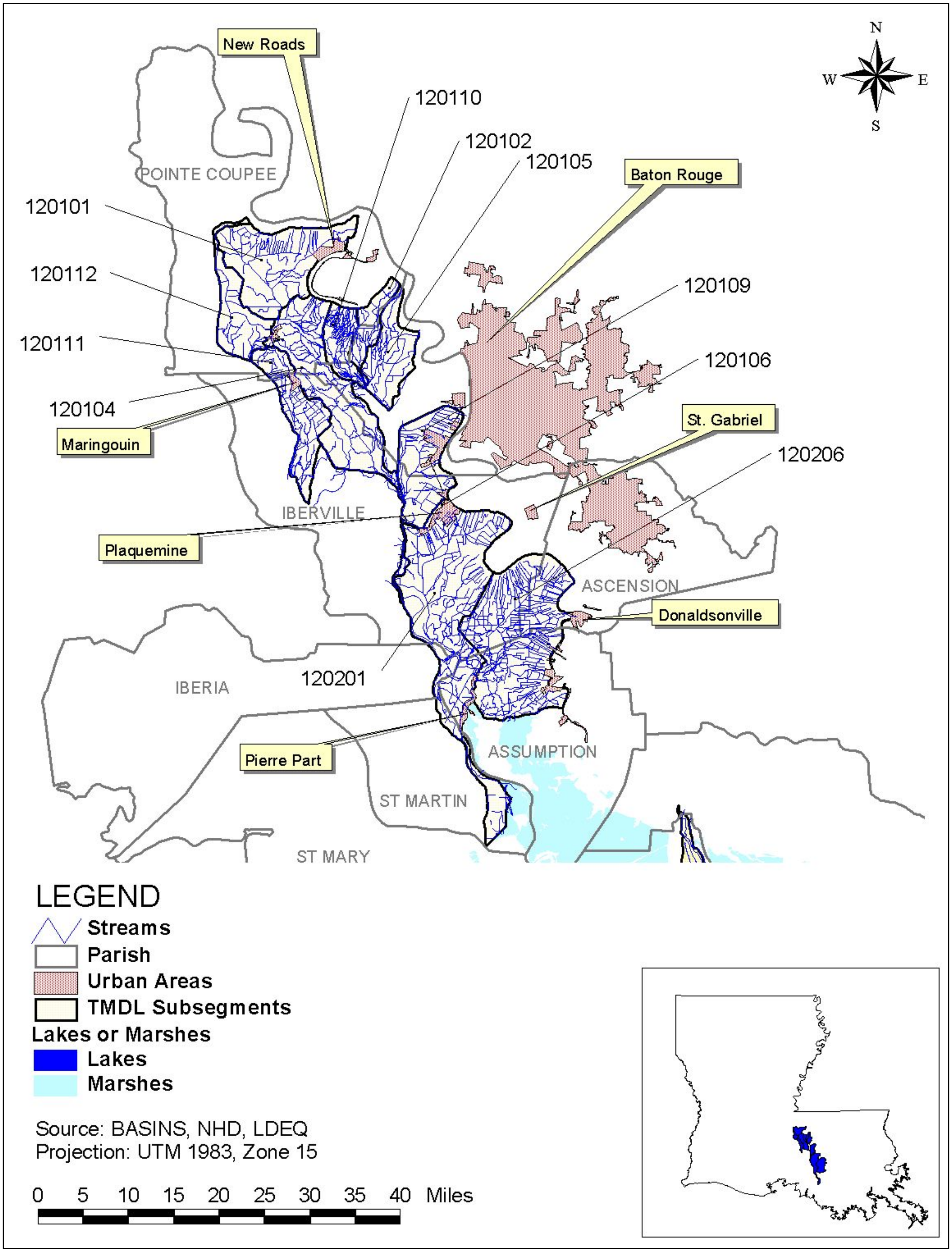

Figure 2-1. Location of the upper Terrebonne River Basin subsegments.

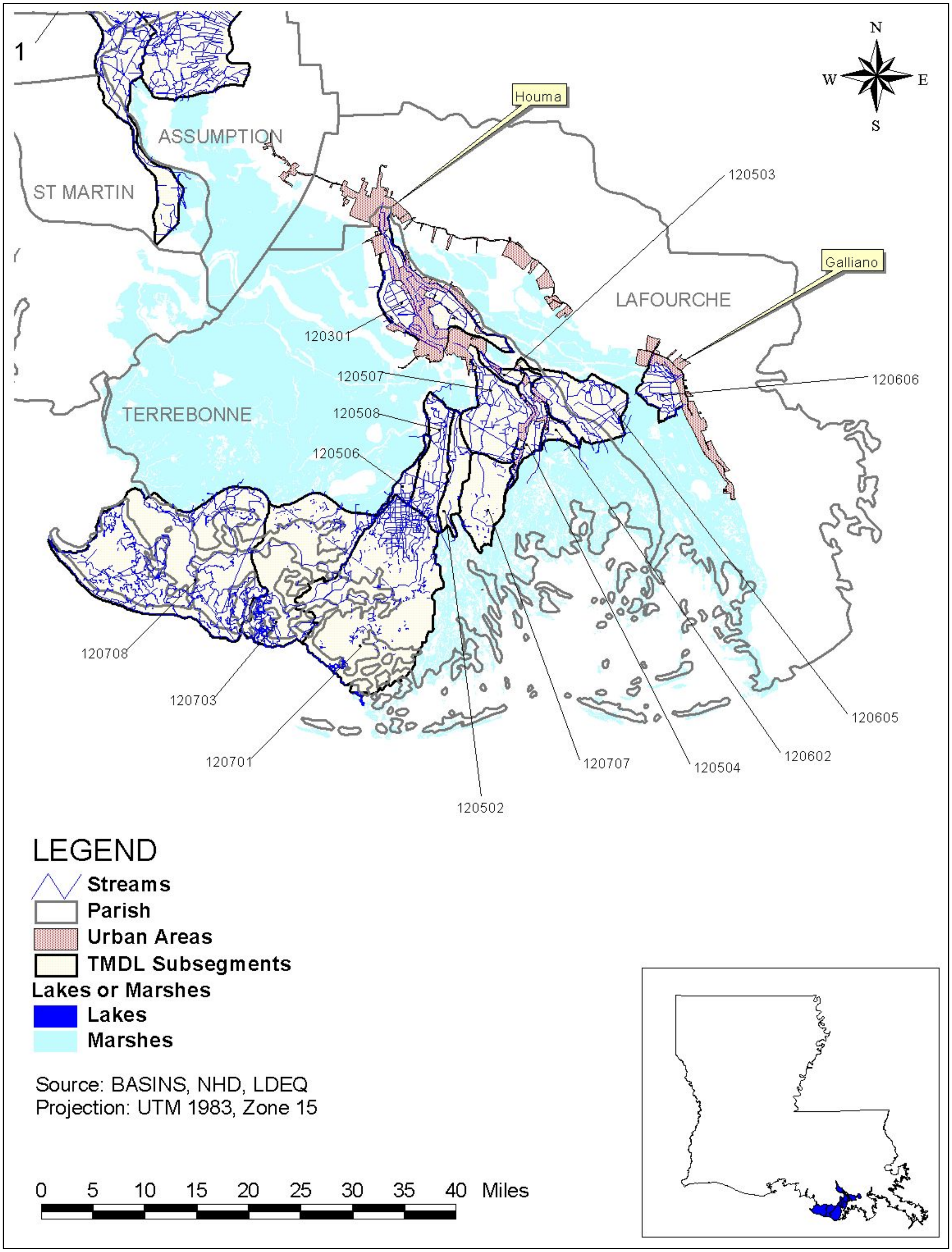

Figure 2-2. Location of the lower Terrebonne River Basin subsegments.

2.2 Land Use

Land use data were obtained from the USGS National Land Cover Data set (NLCD). The NLCD data are based on satellite imagery from the early 1990s. The subsegments in the northern portion of the Terrebonne River Basin (subsegments120101 through 120206) are dominated by agricultural land (pasture/hay and row crops) and wetlands. The majority of the land identified as row crops is in sugarcane production (LDEQ 2005c). There are also some larger urban areas in subsegments 120106 and 120109 that are part of the cities of Baton Rouge and Plaquemine (a suburb of Baton Rouge).

The lower portion of the Terrebonne River Basin (subsegments 120301 through 120708) is dominated by wetlands. The percentage of wetlands in these subsegments ranges from 36 percent in subsegments 120503 and 120707 to 83 percent in subsegment 120605. Subsegment 120301 has the largest urban area in the lower Terrebonne with 11 percent of the subsegment in the city of Houma. Subsegments 120301, 120503, 120504, 120602, and 120606 have large areas of cropland. Table 2-2 lists the percentage of each land use by subsegment, and Figure 2-3 shows the land use coverage for the Terrebonne River Basin.

Table 2-2. Percent land use per subsegment

	Percent coverage by subsegment number								
Land Use	**120101**	**120102**	**120104**	**120105**	**120106**	**120109**	**120110**	**120111**	**120112**
Water	0.3	0.4	0.9	0.1	12.1	3.1	0.7	0.8	0.6
Urban	1.4	2.2	0.9	1.6	10.5	6.9	0.8	3.3	1.5
Barren	0.1	0.0	0.0	0.2	0.0	0.3	0.2	0.1	0.0
Forest	3.1	9.4	4.3	3.7	5.5	2.3	5.3	2.8	4.8
Grasslands/ Herbaceous	0.1	0.0	0.0	0.2	0.0	0.1	0.0	0.0	0.0
Pasture/Hay	25.6	36.8	18.6	29.7	24.3	14.2	18.2	23.0	40.5
Row Crops	27.8	37.9	25.1	35.0	38.8	25.7	27.2	37.5	32.7
Small Grains	0.3	0.5	0.0	4.0	0.9	0.5	0.9	0.2	0.0
Urban/Recreational Grasses	0.5	0.5	0.2	0.9	0.8	0.9	0.0	1.8	2.3
Wetlands	40.8	12.3	50.0	24.7	7.0	46.0	46.7	30.4	17.5
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

	Percent coverage by subsegment number							
Land Use	**120201**	**120206**	**120301**	**120502**	**120503**	**120504**	**120506**	**120507**
Water	3.0	0.5	1.4	11.8	2.1	6.3	33.6	9.6
Urban	2.4	1.3	11.1	3.3	7.1	4.2	2.9	3.3
Barren	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Forest	2.0	5.3	8.5	5.0	0.5	0.3	8.1	2.6
Grasslands/ Herbaceous	0.0	0.0	0.5	0.6	0.4	2.9	0.3	0.3
Pasture/Hay	4.5	7.4	15.7	4.1	15.0	12.7	7.2	3.3
Row Crops	19.5	43.6	11.1	6.8	35.3	16.7	7.2	6.0
Small Grains	1.2	0.6	0.2	0.2	0.7	0.9	0.0	0.2
Urban/Recreational Grasses	1.2	0.5	1.4	0.4	3.2	0.8	0.3	1.3
Wetlands	65.9	40.6	50.1	67.8	35.8	55.2	40.4	73.4
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 2-2. (continued)

Land Use	Percent coverage by subsegment number							
	120508	120602	120605	120606	120701	120703	120707	120708
Water	19.2	19.8	6.3	3.5	48.8	50.8	64.0	40.4
Urban	0.2	3.1	0.5	2.1	0.0	0.0	0.1	0.0
Barren	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.2
Forest	1.9	0.6	0.5	11.2	0.3	0.0	0.0	0.0
Grasslands/ Herbaceous	0.5	0.1	1.6	0.4	0.0	0.0	0.0	0.6
Pasture/Hay	0.5	8.6	3.2	20.2	0.1	0.0	0.0	0.0
Row Crops	2.6	15.1	4.8	10.6	0.0	0.0	0.0	0.0
Small Grains	0.0	0.5	0.0	0.2	0.0	0.0	0.0	0.0
Urban/Recreational Grasses	0.0	0.4	0.1	1.1	0.0	0.0	0.0	0.0
Wetlands	75.0	51.7	83.0	50.6	50.8	49.1	35.8	58.8
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

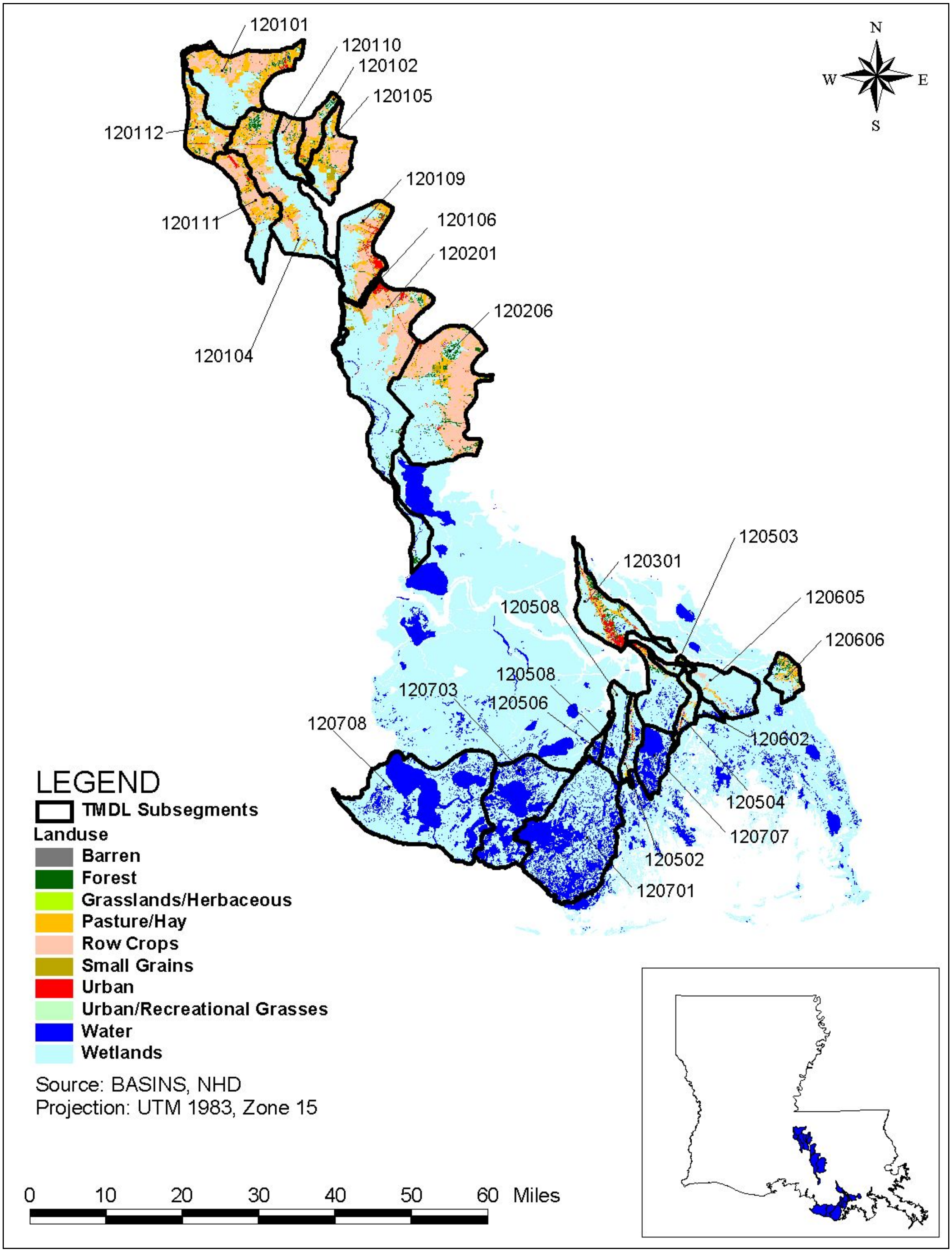

Figure 2-3. Land use in the Terrebonne River Basin subsegments.

2.3 Soils

General soils data for the United States are provided as part of the Natural Resources Conservation Service's (NRCS) State Soil Geographic (STATSGO) database. Soils data from this database and a geographic information system (GIS) coverage from NRCS were used to characterize soils in the Terrebonne River Basin subsegments.

One of the soil characteristics provided in the STATSGO database is the K-factor. The K-factor is a component of the Universal Soil Loss Equation, or USLE (Wischmeier and Smith 1978). The K-factor is a dimensionless measure of a soil's natural susceptibility to erosion, and values can range from 0 to 1.00. In practice, maximum factor values generally do not exceed 0.67. Large K-factor values reflect greater inherent soil erodibility. The distribution of K-factor values in the surface soil layers of the Terrebonne River Basin subsegments is shown in Table 2-3 and Figure 2-4. The figure indicates that, on average, the soils in the basin have K-factors that range from 0.004 to 0.388. The areas without K-factor values are open water. The subsegments in the upper Terrebonne River Basin have the highest K-factors of all the subsegments, suggesting that these soils are more likely to erode than those in the lower Terrebonne. Erosion is also influenced by a number of other factors, including rainfall and runoff, land slope, vegetation cover, and land management practices.

Table 2-3. Soil properties

Subsegment	K-factor range	Surface texture	Hydrologic soil group
120101	0.3173–0.3878	fine sandy loam, silt loam, loamy fine sand, clay, muck, variable, silty clay loam, very fine sandy loam	C, D
120102	0.3238–0.3878	fine sandy loam, silt loam, loamy fine sand, clay, muck, variable, silty clay loam, very fine sandy loam	C, D
120104	0.3173–0.3878	fine sandy loam, silt loam, clay, muck, variable, silty clay loam, very fine sandy loam	C, D
120105	0.3238–0.3878	fine sandy loam, silt loam, loamy fine sand, clay, muck, variable, silty clay loam, very fine sandy loam	C, D
120106	0.3238–0.3878	fine sandy loam, silt loam, clay, muck, variable, silty clay loam, very fine sandy loam	C, D
120109	0.3173–0.3878	fine sandy loam, silt loam, loamy fine sand, clay, muck, variable, mucky clay, silty clay loam, very fine sandy loam	C, D
120110	0.3238–0.3878	fine sandy loam, silt loam, clay, muck, variable, silty clay loam, very fine sandy loam	C, D
120111	0.3173–0.3878	fine sandy loam, silt loam, clay, muck, variable, silty clay loam, very fine sandy loam	C, D
120112	0.3238–0.3878	fine sandy loam, silt loam, loamy fine sandy, clay, muck, variable, silty clay loam, very fine sandy loam	C, D
120201	0.0497–0.3878	fine sandy loam, silt loam, loamy fine sand, clay, muck, variable, silty clay loam, very fine sandy loam	C, D
120206	0.0497–0.3878	fine sandy loam, silt loam, loamy fine sand, clay, muck, variable, mucky peat, silty clay loam, very fine sandy loam	C, D
120301	0.0131–0.3659	silt loam, clay, muck, peat, variable, mucky clay, mucky peat, silty clay loam	C, D

Table 2-3. (continued)

Subsegment	K-factor range	Surface texture	Hydrologic soil group
120502	0.012–0.3527	silt loam, clay, muck, peat, variable, mucky clay, mucky peat, silty clay loam	D
120503	0.2981–0.3527	silt loam, clay, muck, variable, mucky clay, silty clay loam	D
120504	0.012–0.3527	silt loam, clay, muck, peat, variable, mucky clay, silty clay loam	D
120506	0.012–0.3527	silt loam, clay, muck, peat, variable, mucky clay, silty clay loam	D
120507	0.012–0.3527	silt loam, clay, muck, peat, variable, mucky clay, silty clay loam	D
120508	0.012–0.3527	silt loam, clay, muck, peat, variable, mucky clay, mucky peat, silty clay loam	D
120602	0.012–0.3527	silt loam, clay, muck, peat, variable, mucky clay, silty clay loam	D
120605	0.012–0.3527	silt loam, clay, muck, peat, variable, mucky clay, mucky peat, silty clay loam	D
120606	0.012–0.3527	silt loam, clay, muck, peat, variable, mucky clay, mucky peat, silty clay loam	D
120701	0.0043–0.3527	silt loam, loamy fine sand, clay, muck, peat, variable, silty clay loam	D
120703	0.0043–0.3527	silt loam, loamy fine sand, clay, muck, peat, variable, silty clay loam	D
120707	0.012–0.3527	silt loam, clay, muck, peat, variable, silty clay loam	D

The hydrologic soil group classification is another commonly used soil characteristic provided in the STATSGO database. The hydrologic soil group is a means for grouping soils by similar infiltration and runoff characteristics. Clay soils that are poorly drained tend to have the lowest infiltration rates, whereas sandy soils that are well-drained have the highest infiltration rates. NRCS has defined four hydrologic groups for soils (Table 2-4). The STATSGO data were summarized using the major hydrologic group in the soil surface layers (Figure 2-5).

Table 2-4. Hydrologic soil groups

Hydrologic soil group	Description
A	Soils with high infiltration rates. Usually deep, well-drained sands or gravels. Little runoff.
B	Soils with moderate infiltration rates. Usually moderately deep, moderately well-drained soils.
C	Soils with slow infiltration rates. Soils with finer textures and slow water movement.
D	Soils with very slow infiltration rates, high clay content, and poor drainage. High amounts of runoff.

The listed subsegments in the Terrebonne River Basin consist of the C and D hydrologic soil groups. The subsegments in the upper Terrebonne are a mixture of the C and D soils, and the subsegments in the lower Terrebonne are almost entirely D soils. The C and D soils in these watersheds are indicative of the predominance of wet poorly drained soils in the Terrebonne River Basin.

The percentage of soil texture type was also obtained for the subsegments in the basin. All of the subsegments listed for TSS, sediments, or turbidity (subsegments 120101, 120102, 120105, and 120106) are composed mostly of clay, silty clay loam, and silt loam soils.

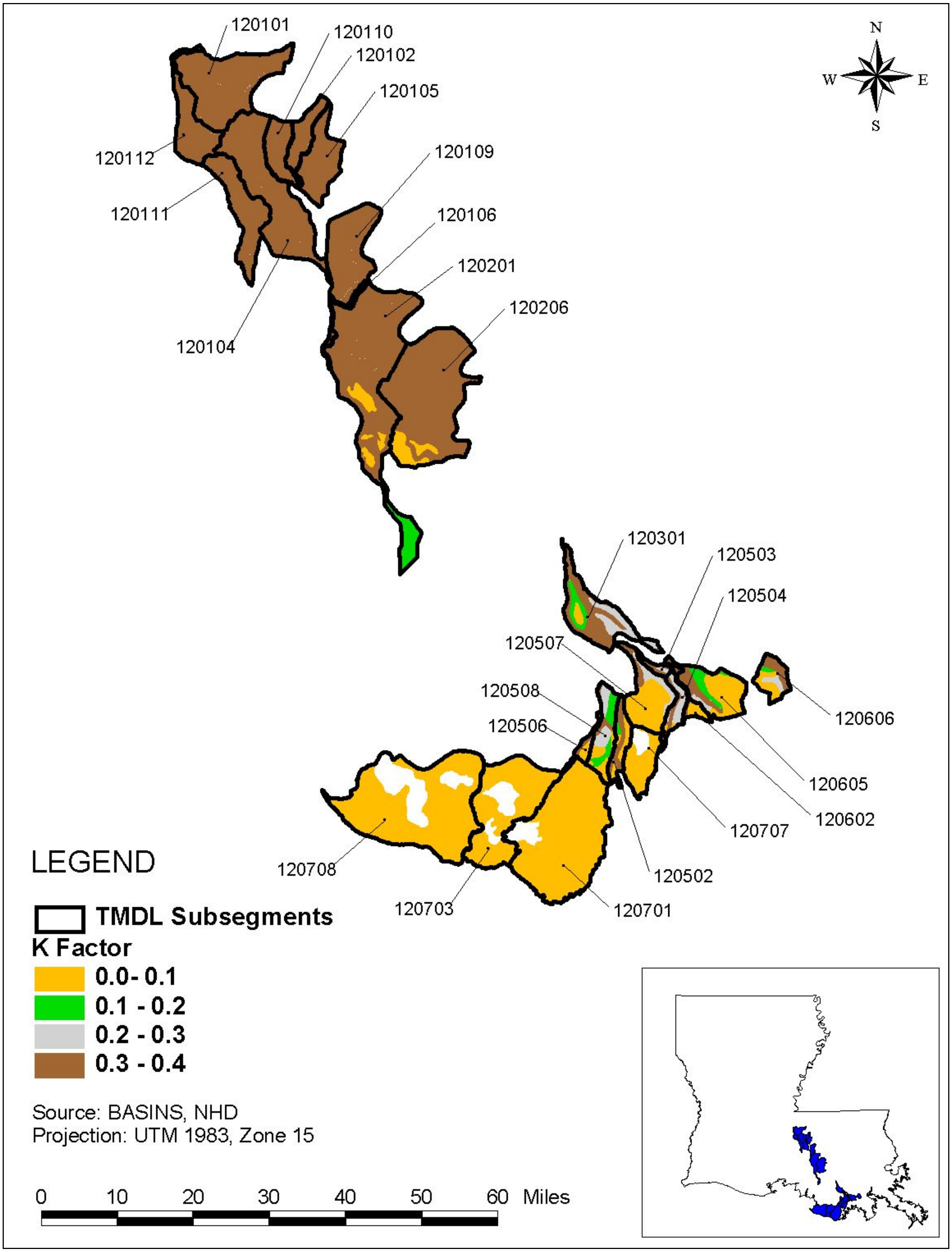

Figure 2-4. Soil K-factor values in the Terrebonne River Basin subsegments.

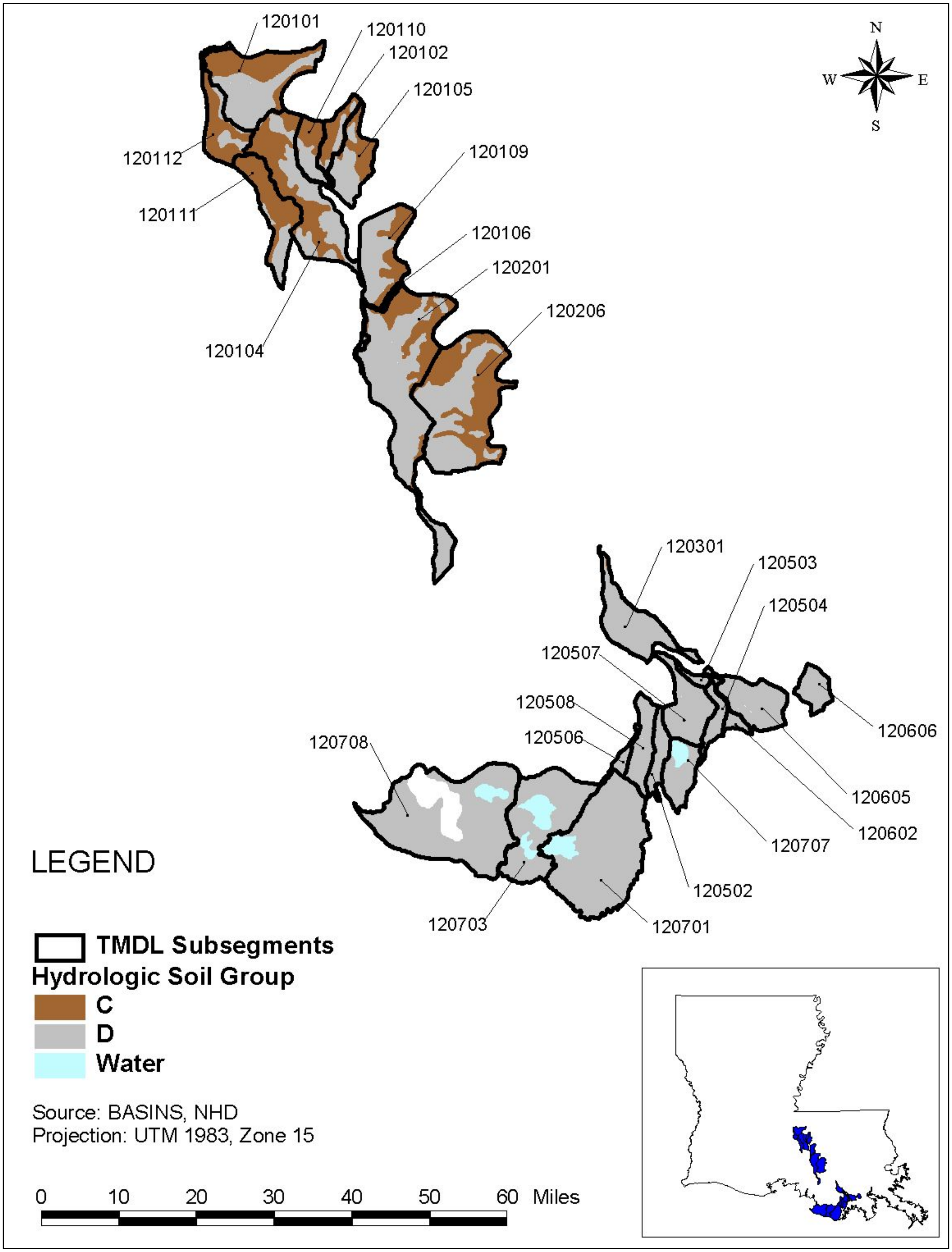

Figure 2-5. Hydrologic soil groups in the Terrebonne River Basin subsegments.

2.4 Flow Characteristics

There are three active USGS flow monitoring gages in the Terrebonne River Basin. However, these gages recorded several zero and negative flow values because of the tidal influences and cannot be used for TMDL development because average flow could not be determined.

2.5 Designated Uses and Water Quality Criteria

Louisiana's 2004 section 303(d) list indicates that the 25 listed subsegments have varied use designations, which include primary contact recreation, secondary contact recreation, fish and wildlife propagation, and shellfish/oyster propagation. Water quality criteria for these subsegments are presented in Table 2-5; the designated uses were presented in Table 1-1.

Primary contact recreation involves any recreational or other water contact use involving full-body exposure with water and considerable probability of the ingestion of water. Examples are swimming and water skiing, whereas, secondary contact recreation involves activities such as fishing, wading, or boating where water contact is accidental or incidental and there is a minimal chance of ingesting appreciable amounts of water.

The designated use of fish and wildlife propagation includes the use of water for aquatic habitat, food, resting, reproduction, cover, or travel corridors for any indigenous wildlife and aquatic life species associated with the aquatic environment. The fish and wildlife propagation use also includes maintaining water quality at a level that prevents damage to native wildlife and aquatic species associated with the aquatic environment and contamination of aquatic life consumed by humans.

The designated use of shellfish/oyster propagation is the use of a waterbody to maintain biological systems that support economically important species of oysters, clams, mussels, or other mollusks so that their productivity is preserved and the health of human shellfish consumers is protected.

Table 2-5 presents the relevant numeric criteria for each subsegment of concern. These numeric criteria were used in conjunction with the assessment methodology presented in LDEQ's 305(b) report (LDEQ 2002b) to list impaired subsegments. The LDEQ assessment methodology specifies that the fish and wildlife designated use be fully supported with up to 30 percent of values exceeding the criteria for chloride, sulfate, and TDS. For fecal coliform bacteria, the primary contact recreation and secondary contact recreation uses must be fully supported with up to 25 percent of the values exceeding the criteria, and the oyster propagation use must be fully supported with up to 10 percent of the values exceeding the criteria.

Table 2-5. Numeric criteria for the subsegments of concern in the Terrebonne River Basin

Subsegment number	Subsegment name	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)	Sediment[a] (mg/L)	TSS[a] (mg/L)	Turbidity (NTU)	Bacteria[b] (colonies/ 100 mL)
120101	Bayou Portage	25		200		X		400 (5/01–10/31) 2,000 (11/01–4/30)
120102	Bayou Poydras		75	500	X	X		400 (5/01–10/31) 2,000 (11/01–4/30)

Table 2-5. (continued)

Subsegment number	Subsegment name	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)	Sediment[a] (mg/L)	TSS[a] (mg/L)	Turbidity (NTU)	Bacteria[b] (colonies/ 100 mL)
120104	Bayou Grosse Tete			200				400 (5/01–10/31) 2,000 (11/01–4/30)
120105	Chamberlin Canal				X	X		400 (5/01–10/31) 2,000 (11/01–4/30)
120106	Bayou Plaquemine						150	
120109	Intracoastal Waterway							400 (5/01–10/31) 2,000 (11/01–4/30)
120110	Bayou Cholpe		25	200				
120111	Bayou Maringouin			200				400 (5/01–10/31) 2,000 (11/01–4/30)
120112	Bayou Fordoche			200				400 (5/01–10/31) 2,000 (11/01–4/30)
120201	Lower Grand River and Belle River		40					400 (5/01–10/31) 2,000 (11/01–4/30)
120206	Grand Bayou and Little Grand Bayou							400 (5/01–10/31) 2,000 (11/01–4/30)
120301	Bayou Terrebonne							400 (5/01–10/31) 2,000 (11/01–4/30)
120502	Bayou Grand Caillou							14 (median) 43 (10%)
120503	Bayou Petit Caillou							14 (median) 43 (10%)
120504	Bayou Petit Caillou							14 (median) 43 (10%)
120506	Bayou du Large							14 (median) 43 (10%)
120507	Bayou Chauvin							400 (5/01–10/31) 2,000 (11/01–4/30)
120508	Houma Navigation Canal							14 (median) 43 (10%)
120602	Bayou Terrebonne							14 (median) 43 (10%)
120605	Bayou Pointe au Chien							400 (5/01–10/31) 2,000 (11/01–4/30)
120606	Bayou Blue							400 (5/01–10/31) 2,000 (11/01–4/30)
120701	Bayou Grand Caillou							14 (median) 43 (10%)
120703	Bayou du Large							14 (median) 43 (10%)
120707	Lake Boudreaux							14 (median) 43 (10%)
120708	Lost Lake, Four League Bay							14 (median) 43 (10%)

[a] No sediment or TSS criteria have been defined in the Louisiana Water Quality Standards. TMDL endpoints were determined through a relationship between TSS and turbidity.
[b] Criteria for primary and secondary contact recreation apply. Primary contact recreation: No more than 25 percent of the total samples collected on a monthly basis shall exceed a fecal coliform bacteria density of 400 colonies/100 mL. Shall apply only during the defined recreational period of 05/01 through 10/31. For all other periods a fecal coliform bacteria density of 2,000 colonies/100 mL for secondary contact recreation applies.
Criteria for oyster propagation. The fecal coliform bacteria median MPN shall not exceed 14 colonies/100 mL, and not more than 10 percent of the samples shall exceed an MPN of 43 colonies/100 mL for a five tube decimal dilution test in those portions of the area most probably exposed to fecal contamination during the most unfavorable hydrographic and pollution conditions.
Source: LDEQ 2005b

Two sets of fecal coliform bacteria criteria are applied to the lower Terrebonne River Basin. Like the upper Terrebonne River Basin, several of the subsegments in the lower basin have primary contact recreation as a designated use; however, most subsegments have shellfish/oyster propagation as a designated use. The criterion for primary contact recreation specifies that fecal coliform bacteria density must not exceed 400 colonies/100 mL (2,000 colonies/100 mL in winter months) in 25 percent of samples on a monthly basis, whereas the criterion for shellfish/oyster propagation is a more stringent 43 colonies/100mL in no more than 10 percent of samples and a median not to exceed 14 colonies/100 mL.

Louisiana's water quality standards (LDEQ 2005b) do not include numerical turbidity criteria for subsegment 120106. The water quality standards state that "turbidity other than that of natural origin shall not cause substantial visual contrast with the natural appearance of the waters of the state or impair any designated water use" (LDEQ 2005b). For purposes of this TMDL, a surrogate turbidity criterion of 150 NTU is applied to subsegment 120106 (Bayou Plaquemine), which is listed for turbidity. 150 NTU is the turbidity criteria for the Mississippi River and is applied to subsegment 120106 because Bayou Plaquemine will be receiving Mississippi River water through a pumping station that will soon go online.

Three subsegments in the Terrebonne River Basin are included on Louisiana's 2004 section 303(d) list for TSS impairments. These three subsegments are 120101 (Bayou Portage), 120102 (Bayou Poydras), and 120105 (Chamberlin Canal). State water quality standards (2005b) provide only narrative water quality criteria for TSS: "there shall be no substances present in concentrations sufficient to produce distinctly visible solids or scum, nor shall there be any formation of long-term bottom deposits of slimes or sludge banks attributable to waste discharges from municipal, industrial, or other sources including agricultural practices, mining, dredging, and the exploration for and production of oil and natural gas".

Subsegments 120102 and 120105 in the Terrebonne River Basin are also listed on the state's 2004 section 303(d) list for sediment impairments. There are no narrative or numeric water quality criteria for sediment in Louisiana.

Antidegradation Policy

The Louisiana water quality standards also include an antidegradation policy (*Louisiana Administrative Code* [LAC] Title 33, Part IX, Section 1109.A), which states that state waters exhibiting high water quality should be maintained at that high level of water quality. If this is not possible, water quality of a level that supports the designated uses of the waterbody should be maintained. The designated uses of a waterbody may be changed to allow a lower level of water quality only through a use attainability study.

2.6 Point Sources

Information on point source discharges in the impaired subsegments was obtained from LDEQ files. The LDEQ stores permit information using internal databases. Data were pulled from these databases and analyzed for this TMDL. Table 2-6 presents point source discharge information for the 21 fecal coliform bacteria discharges included in this TMDL.

This TMDL also includes one point source permitted to discharge chloride (Table 2-7), and four permitted to discharge sulfate (Table 2-8). Table 2-9 presents the point sources permitted to discharge TSS. There are no TDS point source discharges included in these TMDLs.

Table 2-6. Point source discharge information for fecal coliform bacteria in the Terrebonne River Basin

Permit number	Facility name	Location	Outfall	Flow (gpd)[a]	Receiving water	Monthly average permit limit (colonies/ 100 mL)	Weekly average permit limit (colonies/ 100 mL)
Subsegment 120201							
LAG540151	Greenleaf Park Subd	Morgan City, off Hwy 662	001	13,600 (estimated) < 25,000 (permitted)	Bayou L'ourse-Bayou Boeuf	200	400
LAG540162	Wildwood Subd	Morgan City, E of, on Hwy. 662	001	< 7,200 (estimated) < 25,000 (permitted)	Bayou Boeuf	200	400
LAG540542	Oakgrove Apts	Pierre Part, across From Landry St	001	4,400 to 4,800 (daily avg) < 25,000 (permitted)	Drainage-Bayou Natchez-Belle River	200	400
LAG560025	Bayou Pierre Part Sites Subd	Pierre Part, E of, off Hwy 70	001	42,900 (estimated) < 50,000 (permitted)	Lake Verret	200	400
Subsegment 120206							
LAR00C088	Dow Chem Co.	Belle Rose 875 LA Hwy 70	101	300	Grand Bayou		400 (daily max)
LAR00C088	Dow Chem Co.	Belle Rose 875 LA Hwy 70	102	100	Grand Bayou		400 (daily max)
LAR00C088	Dow Chem Co.	Belle Rose 875 LA Hwy 70	103	750	Grand Bayou		400 (daily max)
LAG540036	Sportsmans Paradise Subd	Bayou Corne/Pierre Part, Hwy 70 S	001	15,200 < 25,000 (permitted)	Bayou Corne	200	400
LAG540548	Our Lady of the Lake Hosp Inc.	Napoleonville, 135 Hwy 402	001	7,600 < 25,000 (permitted)	Glenwood Crk-Godchaux-Crk-Lk Verret	200	400
LAG540954	Belle Rose Lane Sewerage Dist	Belle Rose, Hwy 308, 11 M N of	001	14,300 < 25,000 (permitted)	Local Drainage Then To Grand Bayou	200	400
LAG560026	Bayou Tranquille Subd	Belle River, off Hwy 70	001	45,000 < 50,000 (permitted)	Lake Verrett	200	400
WG020066	Lucky Hit Shopping Center	Plattenville, Hwy 70	001	22,080 25,000 (permitted)	Bayou Lafourche	200	400

Table 2-6. (continued)

Permit number	Facility name	Location	Outfall	Flow (gpd)[a]	Receiving water	Monthly average permit limit (colonies/ 100 mL)	Weekly average permit limit (colonies/ 100 mL)
Subsegment 120301							
LA0100072	Houma Facility	Houma, near Houma, 1212 Hwy 90 E	002	730 < 25,000 (permitted)	Local-Hollywood Canal-ICWW		400
LAG530351	Delta Process	Bayou Blue, 104 Dupre St	001	1,500 5,000 (permitted)	Parish Ditch-Hollywood Canal		400
LA0072231	Caro Produce Inc.	Houma, 2324 Bayou Blue Rd	001	< 10,000	Hollywood Canal	200	400
LAG530057	Sunrise Fried Chicken	Bayou Blue, La 316 at Ida St	001	1,120 5,000 (permitted)	Bayou Blue-ICWW		400 (daily max)
LAG540453	Bayou Blue Elem School	Corner Hwy 316 (Lower Bayou Blue) & Hwy 90	001	800 25,000 (permitted)	Bayou Blue		400
LAG530288	Bayou Blue Pontoon Bridge	Bourg, over ICWW on LA 316	001	< 5,000 (permitted)	Intracoastal Waterway		400
Subsegment 120606							
LAG540455	Cut off Elem School	Cut off 115 W 55th St	NA	7,000 25,000 (permitted)	Bayou Lafourche		400
LAG540458	Larose Lower Elem School	Larose 175 Richardel Dr	NA	25,000 (permitted)	Local Drainage then to Bayou Blue		400
LAG540460	Raceland Lower Elem School	Raceland 4101 Hwy 308 S	NA	9,000 25,000 (permitted)	Bayou Lafourche		400

[a] gpd = gallons per day

Table 2-7. Point source discharge information for chloride in the Terrebonne River Basin

Permit number	Facility name	Location	Outfall	Flow (gpd)	Receiving water	Average chloride permit limit (mg/L)	Maximum chloride permit limit (mg/L)
Subsegment 120101							
LA0099210	New Roads Power Plant	New Roads, 215 Oak St	001	5,000	Portage C - Bayou Gross Tete	0.2	0.5
LA0099210	New Roads Power Plant	New Roads, 215 Oak St	002	6,000	Portage C - Bayou Gross Tete	0.2	0.5
LA0099210	New Roads Power Plant	New Roads, 215 Oak St	003	6,000	Portage C - Bayou Gross Tete	0.2	0.5
LA0099210	New Roads Power Plant	New Roads, 215 Oak St	004	6,000	Portage C - Bayou Gross Tete	0.2	0.5
LA0099210	New Roads Power Plant	New Roads, 215 Oak St	005	6,000	Portage C - Bayou Gross Tete	0.2	0.5
LA0099210	New Roads Power Plant	New Roads, 215 Oak St	006	9,000	Portage C - Bayou Gross Tete	0.2	0.5

Table 2-8. Point source discharge information for sulfate in the Terrebonne River Basin

Permit number	Facility name	Location	Outfall	Flow (gpd)	Receiving water	Sulfate permit limit
Subsegment 120201						
LAG540151	Greenleaf Park Subd	Morgan City, off Hwy 662	001	13600 (estimated) < 25,000 (permitted)	Bayou L'ourse-Bayou Boeuf	NA
LAG540162	Wildwood Subd	Morgan City, E of, on Hwy. 662	001	< 7,200 (estimated) < 25,000 (permitted)	Bayou Boeuf	NA
LAG540542	Oakgrove Apts	Pierre Part, Across From Landry St	001	4,400 to 4,800 (daily avg) < 25,000 (permitted)	Drainage-Bayou Natchez-Belle River	NA
LAG560025	Bayou Pierre Part Sites Subd	Pierre Part, E of, off Hwy 70	001	42900 (estimated) < 50,000 (permitted)	Lake Verret	NA

Table 2-9. Point source discharge information for TSS in the Terrebonne River Basin

Permit number	Facility name	Location	Outfall	Flow (gpd)	Receiving water	TSS permit limit
Subsegment 120101						
LA0099210	New Roads Power Plant	New Roads, 215 Oak St	001	5,000	Portage C - Bayou Gross Tete	NA
LA0099210	New Roads Power Plant	New Roads, 215 Oak St	002	6,000	Portage C - Bayou Gross Tete	NA
LA0099210	New Roads Power Plant	New Roads, 215 Oak St	003	6,000	Portage C - Bayou Gross Tete	NA
LA0099210	New Roads Power Plant	New Roads, 215 Oak St	004	6,000	Portage C - Bayou Gross Tete	NA
LA0099210	New Roads Power Plant	New Roads, 215 Oak St	005	6,000	Portage C - Bayou Gross Tete	NA
LA0099210	New Roads Power Plant	New Roads, 215 Oak St	006	9,000	Portage C - Bayou Gross Tete	NA
LAG940014	New Roads Power Plant	New Roads, 215 Oak St	001	360	Portage C - Bayou Gross Tete	NA

Phase I and II stormwater systems are another possible point source contributor in the Terrebonne River Basin. Stormwater discharges are generated by runoff from urban land and impervious areas such as paved streets, parking lots, and rooftops during precipitation events, and these discharges often contain high concentrations of pollutants that can eventually enter nearby waterbodies. Most stormwater discharges are considered point sources and require coverage by a National Pollutant Discharge Elimination System (NPDES) permit.

Under the NPDES stormwater program, operators of large, medium, and regulated small municipal separate storm sewer systems (MS4s) require authorization to discharge pollutants. The Stormwater Phase I Rule (55 *Federal Register* 47990; November 16, 1990) requires all operators of medium and large MS4s to obtain an NPDES permit and develop a stormwater management program. Medium and large MS4s are defined by the size of the population within the MS4 area, not including the population served by combined sewer systems. A medium MS4 has a population size between 100,000 and 249,999. A large MS4 has a population of 250,000 or more. The only Phase I MS4 in the Terrebonne River Basin is Baton Rouge, Louisiana.

Phase II requires a select subset of small MS4s to obtain an NPDES stormwater permit. A small MS4 is any MS4 not already covered by the Phase I program as a medium or large MS4. The Phase II Rule automatically covers all small MS4s in urbanized areas (UAs), as defined by the Bureau of the Census, and also includes small MS4s outside a UA that are so designated by NPDES permitting authorities, case by case (USEPA 2000).

In Louisiana there are two ways that an MS4 can be identified as a regulated small MS4. This category includes all cities within UAs and any small MS4 area outside UAs with a population of at least 10,000 and a population density of at least 1,000 people per square mile (LDEQ 2002a). In the Terrebonne River Basin, the city of Houma is a regulated small MS4. Table 2-10 presents MS4 information by subsegment for the Terrebonne River Basin.

Table 2-10. MS4 information for the Terrebonne River Basin

Subsegment number	Subsegment name	Urban area (UA)	MS4 area (acres)	Phase I or II
120109	Intracoastal Waterway	Baton Rouge	40	Phase I
120301	Bayou Terrebonne	Houma	1,448	Phase II
120507	Bayou Chauvin	Houma	166	Phase II
120503	Bayou Petit Caillou	Houma	57	Phase II
120504	Bayou Petit Caillou	Houma	260	Phase II
120602	Bayou Terrebonne	Houma	64	Phase II
120605	Bayou Pointe au Chien	Houma	28	Phase II

2.7 Nonpoint Sources

Fecal Coliform Bacteria

Louisiana’s 2004 section 303(d) list identifies wildlife other than waterfowl, marina/boating on-vessel discharges, and unknown sources as the suspected nonpoint sources of the fecal coliform bacteria impairment in the Terrebonne River Basin subsegments. Pat Brogue at the Bayou Lafourche LDEQ Regional Office offered additional insight on what might be causing the impairments in the two subsegments with unknown sources of fecal coliform bacteria (personal communication, July 26, 2005). Brogue suggested that wildlife and vessel discharges are a possible source in subsegment 120508 (Houma Navigation Canal). He also suggested that potential sources of fecal coliform bacteria impairment for subsegment 120701 (Grand Bayou Caillou) might be wildlife (large duck population), vessel discharges, and camps (e.g., hunting camps).

The suspected sources of fecal coliform bacteria to Bayou Pointe au Chien (subsegment 120605) and Lost Lake/Four League Bay (subsegment 120708) are wildlife other than waterfowl.

According to Pat Brogue, these wildlife are most likely nutria and possibly muskrats (personal communication, July 26, 2005).

Although not included on the section 303(d) list, pastureland is also a potential source of fecal coliform bacteria to Bayou Grosse Tete (subsegment) according to LDEQ's *2000 Annual Nonpoint Source Report* (LDEQ 2000).

Additional potential sources of fecal coliform bacteria, not included on the section 303(d) list, are failing septic or sewer systems. A 2001 survey of septic systems (DHH 2001) in the Lower Terrebonne River Basin provides the numbers of septics per subsegment (Table 2-11).

Table 2-11. Septic systems by subsegment in the lower Terrebonne River Basin

Subsegment number	Subsegment name	Number of septic systems
120201	Lower Grand River and Belle River	683
120206	Grand Bayou and Little Grand Bayou	543
120301	Bayou Terrebonne	1,418
120502	Bayou Grand Caillou	391
120503	Bayou Petit Caillou	384
120504	Bayou Petit Caillou	739
120506	Bayou du Large	103
120507	Bayou Chauvin	284
120508	Houma Navigation Canal	88
120602	Bayou Terrebonne	174
120605	Bayou Pointe au Chien	137
120606	Bayou Blue	491
120701	Bayou Grand Caillou	7
120703	Bayou du Large	33
120707	Lake Boudreaux	135

Chloride

The LDEQ section 303(d) list identifies irrigated and nonirrigated crop production as potential nonpoint sources of chloride in the Terrebonne River Basin. Typically, sources of dissolved minerals include urban and agricultural runoff, forestry, and natural geology. Chloride is found in all human and animal wastes, and therefore septic systems and areas where animal wastes are deposited can be chloride sources. Fertilizers are also a common source of chlorides (University of Florida 2003).

Sulfate

The LDEQ section 303(d) list identifies drainage filling, loss of wetlands, irrigated and nonirrigated crop production, drought-related impacts, and petroleum/natural gas activities as potential nonpoint sources of sulfate in the Terrebonne River Basin. Sulfate is a naturally occurring mineral in some soils and rock formations. Sources of dissolved minerals often include urban and agricultural runoff, forestry, and geology.

Total Dissolved Solids

The Louisiana section 303(d) list identifies irrigated and nonirrigated crop production, drainage filling, loss of wetlands, and drought-related impacts as potential nonpoint sources of TDS in the Terrebonne River Basin. Sources of TDS can originate from natural sources (e.g., mineral springs, carbonate deposits, salt deposits, seawater intrusion) and urban and agricultural runoff (Wilkes University 2005).

Turbidity

This report addresses only one subsegment listed for turbidity, 120106 (Bayou Plaquemine). According to the Louisiana section 303(d) list, the source of impairment is unknown. The land use coverage for the watersheds shows that a large portion of this subsegment is in pasture/hay and cropland (63 percent) and 10.5 percent of the subsegment is urban. The runoff from both of these land uses could be causing increased turbidity levels.

Sediment

Subsegments 120102 and 120105 are both included on the Louisiana 2004 section 303(d) list for sediment impairments, but the source is unknown. Both of these subsegments are dominated by agricultural land uses (see Section 2.2), which are a possible source of sediment to the listed waterbodies.

Total Suspended Solids

The source of TSS in all three subsegments (120101, 120102, and 120105) included on the section 303(d) list for TSS impairments is unknown. Two of the three subsegments are also listed for sediment (subsegments 120102 and 120105). Subsegment 120101, like the other two subsegments, is dominated by agricultural land uses (25.6 percent and 27.8 percent pasture/hay and row crops, respectively). These land uses are a possible source of TSS to the subsegments.

3 CHARACTERIZATION OF EXISTING WATER QUALITY

Water quality data were obtained from LDEQ. There are 40 water quality stations with data relevant to the subsegments addressed in this report. Fourteen of those stations are in the upper Terrebonne River Basin and the remaining 26 are in the lower basin. Each subsegment has at least one water quality station in it, while other subsegments have two. No subsegment has more than two active water quality stations. Figures 3-1 and 3-2 show the locations of the water quality gages in the upper and lower Terrebonne River Basin, respectively.

3.1 Comparison of Observed Data to Criteria

Fecal Coliform Bacteria

There are 23 subsegments listed for fecal coliform bacteria impairments on Louisiana's 2004 section 303(d) list. Seven of these subsegments have observations at two water quality stations. The other 16 subsegments have only one data set per subsegment. Tables A-1 (primary contact recreation) and A-2 (shellfish/oyster propagation) in Appendix A present a summary of the observations at each water quality station by subsegment, including the number of observations; the minimum, maximum, and median observations; the number of exceedances of the criteria; and the percentage of observations exceeding criterion at each station. Appendix B contains the original water quality data.

The station with the most fecal coliform bacteria observations is station 113 in subsegment 120502 (Bayou Grand Caillou at Dulac, Louisiana) with 167 observations collected between 1978 and 2000. The lowest number of observations at any station is two at station 2844 (subsegment 120606).

Exceedances of the summer primary contact recreation criterion (400/100 mL) from May 1 through October 31 were observed at all but three stations, with the highest percentage of exceedances (100 percent) at station 968 in subsegment 120101 (Bayou Portage). Eight subsegments also have exceedances of the winter criterion (2,000/100 mL), which is applied from November 1 through April 30. The highest percentage of winter exceedances (67 percent) is also at station 968 on Bayou Portage.

All 10 subsegments designated for shellfish/oyster propagation exceed the median criterion of 14/100 mL. Nine of the 10 subsegments exceed the 43/100 mL criterion with exceedances ranging from 36 percent (subsegment 120508, station 344) to 100 percent (subsegment 120503, station 939).

Chloride

There is one chloride data set available for the chloride-impaired subsegment 120101 (Bayou Portage), at water quality station 968. Table A-3 in Appendix A presents a summary of the observations at the water quality station including the number of observations; the minimum, maximum, and median observations; the number of exceedances of the criterion; and the

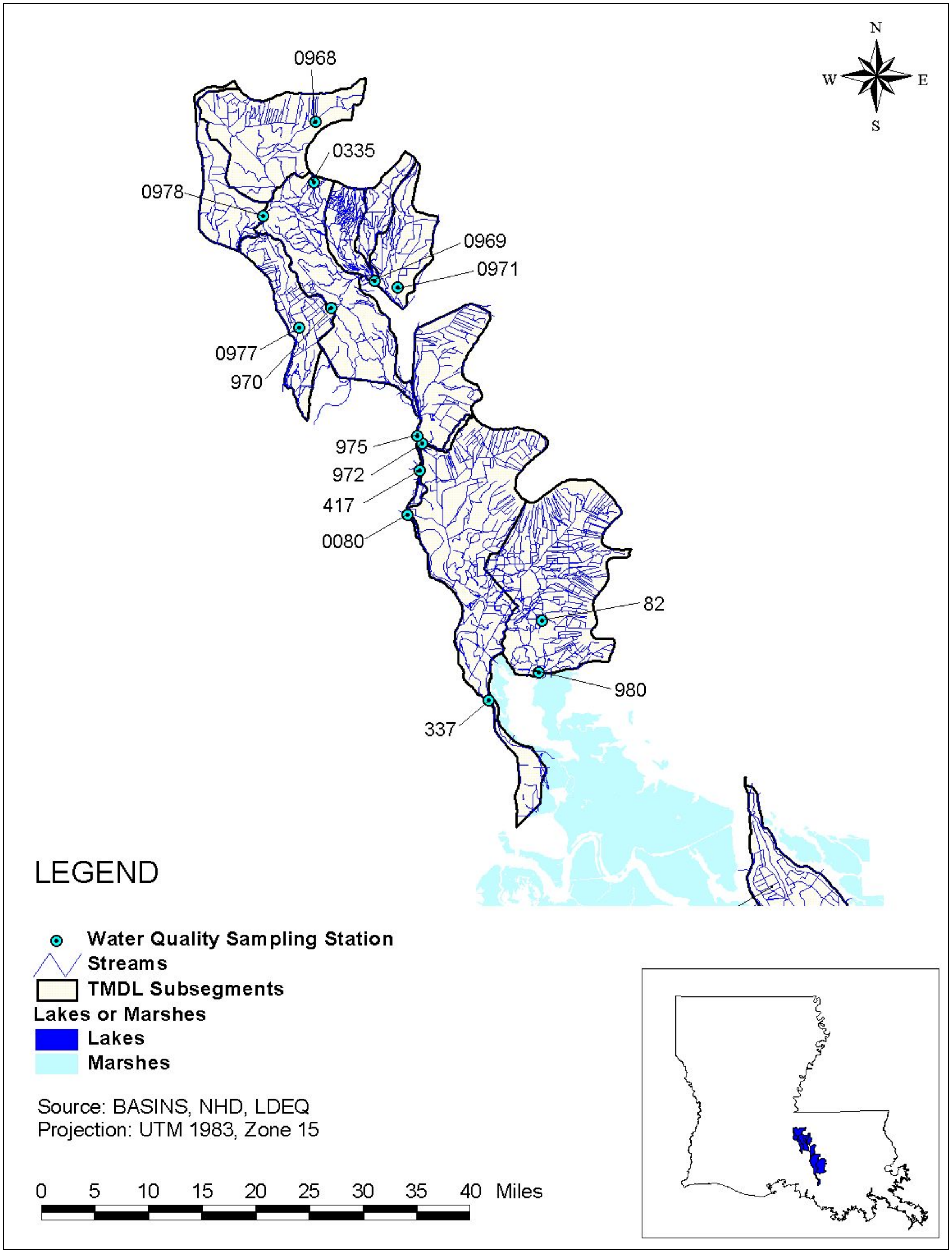

Figure 3-1. Location of water quality sampling stations and the USGS gage in the upper Terrebonne River Basin.

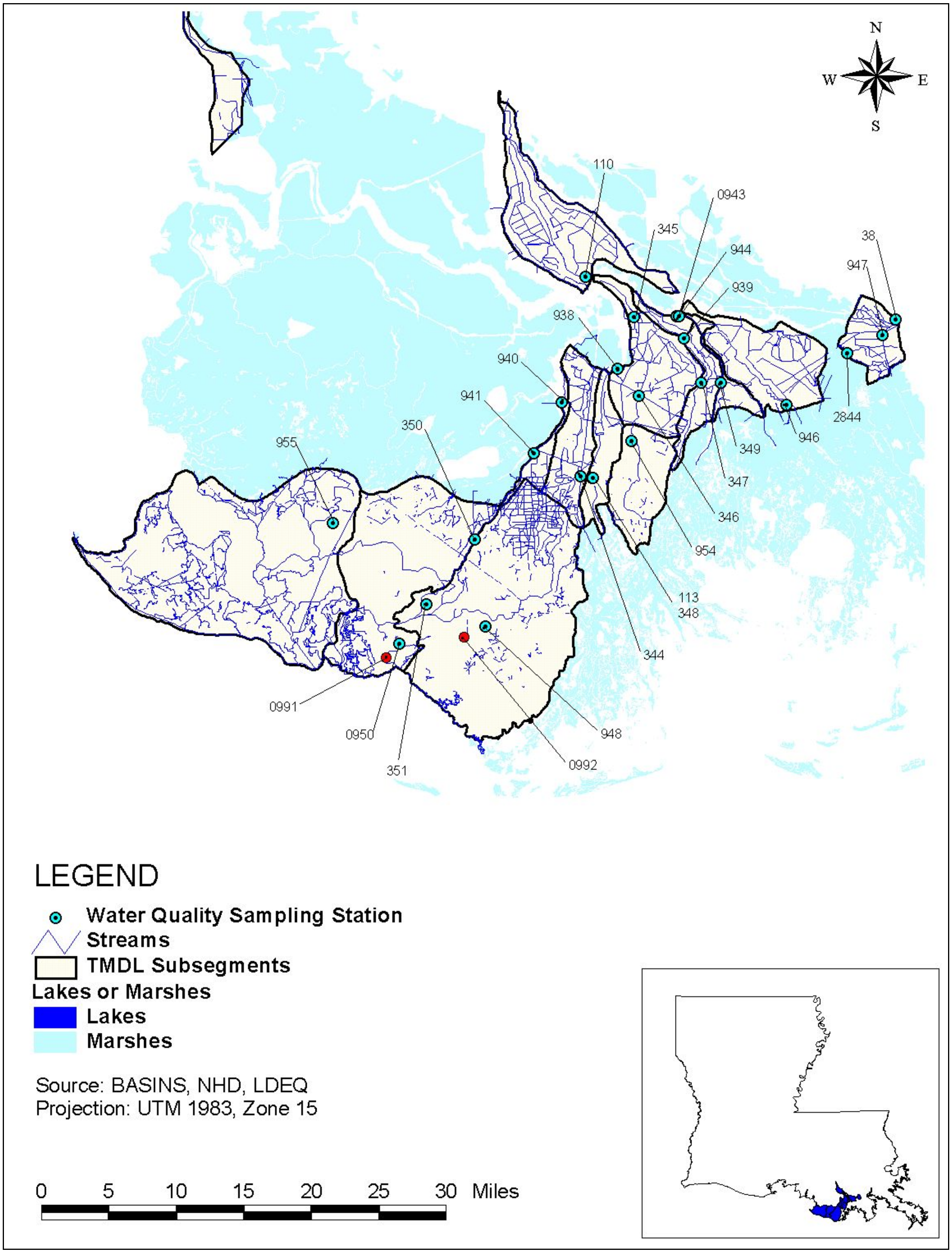

Figure 3-2. Location of water quality sampling stations in the lower Terrebonne River Basin.

percentage of observations exceeding the criterion. Appendix B contains the original water quality data. Station 968 has 15 observations from February 2000 through April 2004. Sixty percent of the observations exceed the 25 mg/L chloride criterion for Bayou Portage.

Sulfate

One sulfate data set is available for the sulfate-impaired subsegments of 120102 and 120110. Subsegment 120201 has two water quality stations with sulfate observations. Table A-4 in Appendix A presents a summary of the observations at each water quality station by subsegment, including the number of observations; the minimum, maximum, and median observations; the number of exceedances of the criteria; and the percentage of observations exceeding the criterion at each station. Appendix B contains the original water quality data.

Each subsegment has one station with sulfate observations from February 2000 through April 2004. In addition to those data, station 337 on Belle River (subsegment 120201) has data from May 1991 through September 1997. All subsegments have at least 15 sulfate observations, while station 337 in subsegment 120201 has 45 observations. Station 969 in subsegment 120102 (Bayou Portage) has the highest percentage of exceedances of the criterion (87 percent). The lowest percentage of exceedances is at station 337 (subsegment 120201) with 13 percent.

Total Dissolved Solids

Each of the six TDS-impaired subsegments addressed in this report has one water quality station with TDS observations. Table A-5 in Appendix A presents a summary of the observations at each water quality station by subsegment, including the number of observations; the minimum, maximum, and median observations; the number of exceedances of the criteria; and the percentage of observations exceeding criterion at each station. Appendix B contains the original water quality data.

Each station has 15 TDS observations except for station 978 in subsegment 120112, which has 14 observations. The percentages of observations exceeding the TDS criteria range from 40 percent (subsegment 120102) to 93 percent (subsegments 120101 and 120110).

Turbidity

There is one water quality station (972) for subsegment 120106 (Bayou Plaquemine), which is included on the Louisiana 2004 section 303(d) list for turbidity impairment. Table A-6 in Appendix A presents a summary of the observations at station 972, including the number of observations; the minimum, maximum, and median observations; the number of exceedances of the criterion; and the percentage of observations exceeding the criterion. Appendix B contains the original water quality data.

There are 15 turbidity observations at station 972 for the period of record, February 2000 through April 2004. The maximum observation was 100 NTUs, and the minimum was 26 NTUs. None of the turbidity observations at station 972 exceeds the 150 NTU turbidity criterion for Bayou Plaquemine.

Sediment

Although subsegments 120102 and 120105 are listed for sediment impairments on the section 303(d) list, there are no data collected specifically for sediment in the Terrebonne River Basin. The TSS data (see below) were used to characterize the sediment impairments in the basin.

Total Suspended Solids

Each of the three subsegments listed for TSS impairments on the section 303(d) list has one water quality station with 15 TSS observations from February 2000 through April 2004. Table A-7 in Appendix A presents a summary of the observations at stations 968 (subsegment 120101), 969 (subsegment 120102), and 971 (subsegment 120105) including the number of observations; the minimum, maximum, and median observations; the number of exceedances of the criteria; and the percentage of observations exceeding the criteria. Appendix B contains the original water quality data.

The maximum TSS observation in any of the subsegments is 770 mg/L at station 968 (subsegment 120101). There is one exceedance of the TSS criteria at station 968, resulting in an exceedance of 7 percent. None of the observations exceeds the criteria at the stations on subsegments 120102 (station 969) and 120105 (station 971). Therefore, only subsegment 120101 exceeds the TSS criteria.

3.2 Trends and Patterns in Observed Data

Because of the limited number of samples at most of the water quality stations, no distinct trends or patterns are seen in the water quality data results to make significant comparisons. Appendices C through H contain the sampling results for fecal coliform bacteria, chloride, sulfate, TDS, turbidity, and TSS plotted over time.

4 TMDL DEVELOPMENT

A TMDL is the total amount of a pollutant that can be assimilated by the receiving waterbody while still achieving water quality standards. In TMDL development, allowable loadings from all pollutant sources that cumulatively amount to no more than the TMDL must be established and thereby provide the basis for establishing water quality-based controls.

A TMDL for a given pollutant and waterbody is composed of the sum of individual wasteload allocations (WLAs) for point sources, and load allocations (LAs) for nonpoint sources and natural background levels. In addition, the TMDL must include an implicit or explicit margin of safety (MOS) to account for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. This TMDL also includes a future growth (FG) component to account for loadings from the continued growth in the TMDL area. The TMDL components are illustrated using the following equation:

$$TMDL = \sum WLAs + \sum LAs + MOS + FG$$

For some pollutants, TMDLs are expressed on a mass loading basis (e.g., kilograms per day). For bacteria, however, TMDLs can be expressed in terms of organism counts (or resulting concentration), in accordance with 40 CFR 130.2(l).

4.1 TMDL Analytical Approach

The TMDLs in the Terrebonne River Basin were calculated using a concentration reduction approach. Using this approach, the percent reduction for each LDEQ monitoring station was calculated on the basis of observed pollutant concentrations. The minimum percent reduction was calculated so that the monitoring data would meet criteria at that station. The percent reduction was applied to the entire subsegment. If two monitoring stations were present in a subsegment, the larger percent reduction was used to ensure that both monitoring stations meet criteria. The new reduced average concentration was used to determine the TMDL loading. TMDL calculations are included in Appendix I.

Because of the lack of flow data in the Terrebonne River Basin, the monthly water yield (runoff in millimeters) was used to obtain TMDL loadings. The monthly water yield for the Central, South Central, and South East Climate Divisions were obtained from the Louisiana Office of State Climatology. The monthly water yield was divided by the number of days in the month to obtain runoff intensity. Data from 1980 to the present were averaged to obtain summer (May through October), winter (November through April), and yearly averages, which are listed in Table 4.1. These averages were assigned to each subsegment according to their location. If a subsegment was part of more than one division, the percent area of the subsegment was estimated for each of the divisions, and the yield for that subsegment was calculated from these percents and the water yields of the divisions. For example, subsegment 120104 is 50 percent in the Central and 50 percent in the South Central Divisions. So the average monthly water yield for each division was multiplied by 50 percent and added together to get the average water yield for that subsegment.

Table 4-1. Average water yields for climate divisions in the Terrebonne River Basin

Climate division	Summer average monthly water yield (millimeters)	Winter average monthly water yield (millimeters)	Yearly average monthly water yield (millimeters)
Central	1.594	3.081	2.337
South Central	2.206	2.550	2.378
South East	2.245	2.558	2.402

After analyses of the applicable water quality criteria, most fecal coliform bacteria TMDLs were developed on a seasonal basis (i.e., calculating allowable loads and percent reductions for both summer and winter). Subsegments with oyster propagation as its designated use had fecal coliform bacteria TMDLs developed to apply year-round, as did the other pollutants (chloride, sulfate, TDS, TSS, and turbidity).

Sediment, TSS, and Turbidity

Because turbidity is a measure of the water's optical properties that cause light to be scattered or absorbed, the percent reduction was based on a surrogate parameter, total suspended solids (TSS). Turbidity can be affected by different suspended particles such as clay, silt, and microorganisms, many of which are the same substances that form TSS. Turbidity can also be affected by algae and watercolor; however, for these TMDLs, TSS is assumed the dominant source of turbidity. Because the state of Louisiana has not developed numeric criteria for TSS, a regression analysis of turbidity and TSS data was performed. This analysis indicates that TSS is an appropriate surrogate for turbidity.

Because only narrative criteria are available for TSS, it was necessary to calculate a numeric endpoint for TSS to develop the TMDL. The TSS endpoint was calculated on the basis of the relationship between turbidity and TSS using the same methodology (regression analysis) used to calculate the surrogate TSS value for turbidity for subsegment 120106. The resulting equations from the regression analysis were used to calculate the TSS endpoint using the turbidity criteria for the Mississippi River (150 NTU) as the Y value. The Mississippi River turbidity criterion was used because the other three subsegments, listed for TSS, eventually drain into the Gulf Intracoastal Waterway (the Port Allen to Morgan City route), which gets most of its water from the Mississippi at Port Allen. The equations were solved for X to determine the TSS value associated with a turbidity value of 150 NTU.

Subsegments 120102 and 120105 are listed for sediment as well as TSS. Because there are no criteria for sediment and sediment is closely related to TSS, it was assumed that the TMDLs for TSS on those subsegments would address the sediment impairment as well.

Table 4-2 presents the regression equations, R^2 value, and resulting TSS endpoints for each of the subsegments listed for turbidity, TSS, and sediment. The TSS versus turbidity plots are presented in Appendix J. The R^2 values demonstrate that there is a correlation between turbidity and TSS, albeit not a strong one, and that TSS can be used as a surrogate.

For TMDL calculations (Appendix I), the calculated TSS endpoint was compared to existing TSS data. Results from these calculations are used in this report and as the loads assigned to the watersheds. An alternative method of determining the TMDL and percent reduction is to use TSS concentrations that are calculated the same way the end point is. TMDLs and percent reductions were calculated in this manner, and provided similar, often identical loads and percent reductions. These calculations are included in Appendix K for comparison.

Table 4-1. Surrogate turbidity, TSS, and sediment criteria for the Terrebonne River Basin

Subsegment number	Subsegment name	Regression equation	R^2 value	Turbidity endpoint (NTU)	Calculated TSS endpoint (mg/L)
120106	Bayou Plaquemine	y = 1.1820x + 2.2569	0.6636	150	125
120101	Bayou Portage	y = 0.4148x + 29.836	0.8979	150	290
120102	Bayou Poydras	y = 0.5421x + 16.054	0.7656	150	247
120105	Chamberlin Canal	y = 0.3852x + 33.669	0.2412	150	302

4.2 TMDL, WLA, and LA

The reduced average concentration and the average water yield were multiplied by the estimated subsegment area, which was assumed to represent the drainage area for the subsegment. Tables 4-3, 4-4, and 4-5 present a summary of the TMDLs and allocations for the subsegments included in this report.

Both section 303(d) of the Clean Water Act and the regulations at 40 CFR 130.7 require that TMDLs include an MOS to account for uncertainty in available data or in the actual effect that controls will have on the loading reductions and receiving water quality. The MOS may be expressed explicitly as unallocated assimilative capacity or implicitly using conservative assumptions in establishing the TMDL. For a more detailed discussion of the MOS, see Section 4.4. In addition to the MOS, an FG component was added for an additional MOS to account specifically for future growth in the TMDL area (see Section 4.5).

Table 4-3. Summary of fecal coliform bacteria TMDLs, MOS, FG, WLAs, and LAs for the Terrebonne River Basin

Subsegment	Station	Season	Percent reduction	Total allowable loading	Explicit MOS (10%)	Future growth (10%)	∑ WLA	∑ LA
				1×10^9 colonies/day				
120101	968	Summer	92.0	146.48	14.65	14.65	0.00	117.18
120101	968	Winter	87.5	732.70	73.27	73.27	0.00	586.16
120102	969	Summer	20.0	110.37	11.04	11.04	0.00	88.30
120102	969	Winter	0.0	176.64	17.66	17.66	0.00	141.31
120104	970	Summer	64.0	127.53	12.75	12.75	0.00	102.02
120104	970	Winter	0.0	660.00	66.00	66.00	0.00	528.00
120105	971	Summer	92.0	30.99	3.10	3.10	0.00	24.79
120105	971	Winter	0.0	68.96	6.90	6.90	0.00	55.17
120109	80	Summer	20.0	183.45	18.35	18.35	1.54	145.22
120109	80	Winter	0.0	355.97	35.60	35.60	2.99	281.79

Table 4-3. (continued)

Subsegment	Station	Season	Percent reduction	Total allowable loading	Explicit MOS (10%)	Future growth (10%)	∑ WLA	∑ LA
				1×10^9 colonies/day				
120111	977	Summer	86.7	42.77	4.28	4.28	0.00	34.22
120111	977	Winter	0.0	51.24	5.12	5.12	0.00	40.99
120112	978	Summer	64.0	110.64	11.06	11.06	0.00	88.51
120112	978	Winter	16.7	893.61	89.36	89.36	0.00	714.88
120201	979	Summer	20.0	356.63	35.66	35.66	0.95	284.36
120201	979	Winter	0.0	752.72	75.27	75.27	0.95	601.23
120206	82	Summer	20.0	693.55	69.35	69.35	1.16	553.68
120206	82	Winter	0.0	1,993.61	199.36	199.36	1.16	1,593.74
120301	110	Summer	94.94	247.45	24.74	24.74	87.79	110.17
120301	110	Winter	62.96	5,584.35	558.43	558.43	1,973.02	2,494.46
120502	113	Year	96.69	1.34	0.13	0.13	0.00	1.08
120503	939	Year	95.33	0.35	0.04	0.04	0.06	0.23
120504	347	Year	98.21	0.97	0.10	0.10	0.23	0.54
120506	941	Year	91.40	0.69	0.07	0.07	0.00	0.55
120507	345	Summer	20.00	235.32	23.53	23.53	12.04	176.21
120507	345	Winter	0.00	229.95	23.00	23.00	11.77	172.19
120508	344	Year	81.30	3.88	0.39	0.39	0.00	3.11
120602	349	Year	98.21	0.73	0.07	0.07	0.08	0.51
120605	946	Summer	20.00	114.62	11.46	11.46	0.99	90.71
120605	946	Winter	0.00	75.85	7.59	7.59	0.65	60.03
120606	947	Summer	20.00	18.15	1.81	1.81	0.57	13.95
120606	947	Winter	0.00	20.22	2.02	2.02	0.57	15.61
120701	351	Year	30.00	26.99	2.70	2.70	0.00	21.59
120703	350	Year	89.23	18.44	1.84	1.84	0.00	14.76
120707	954	Year	74.71	3.98	0.40	0.40	0.00	3.19
120708	955	Year	81.30	19.90	1.99	1.99	0.00	15.92

Table 4-4. Summary of chloride and sulfate TMDLs, MOS, FG, WLAs, and LAs for the Terrebonne River Basin

Subsegment	Station	Pollutant	Percent reduction	Total allowable loading	Explicit MOS (10%)	Future growth (10%)	∑ WLA	∑ LA
				kg/day				
120101	968	Chloride	53.4	679.7	68.0	68.0	8.3	535.4
120102	969	Sulfate	82.5	417.9	41.8	41.8	0.0	334.3
120110	976	Sulfate	84.1	136.1	13.6	13.6	0.0	108.9
120201	979	Sulfate	44.4	2,485.9	248.6	248.6	14.2	1,974.5

Table 4-5. Summary of TDS, sediment, TSS, and turbidity TMDLs, MOS, FG, WLAs, and LAs for the Terrebonne River Basin

Subsegment	Station	Pollutant	Percent reduction	Total allowable loading	Explicit MOS (10%)	Future growth (10%)	∑ WLA	∑ LA
				tons/day				
120101	968	TDS	66.4	6.50	0.65	0.65	0.00	5.20
120102	969	TDS	43.7	4.04	0.40	0.40	0.00	3.23
120104	970	TDS	32.4	10.31	1.03	1.03	0.00	8.25
120110	976	TDS	55.6	2.17	0.22	0.22	0.00	1.74
120111	977	TDS	63.2	3.31	0.33	0.33	0.00	2.64
120112	978	TDS	43.8	3.37	0.34	0.34	0.00	2.69
120101	968	TSS	62.4	2.48	Implicit	0.25	0.00	2.24
120102	969	Sediment/ TSS	0.0	1.21	Implicit	0.12	0.00	1.09
120105	971	Sediment/ TSS	0.0	2.15	Implicit	0.22	0.00	1.94
120106	972	Turbidity as TSS	0.0	0.07	Implicit	0.01	0.00	0.06

Hurricane Katrina made landfall on Monday, August 29, 2005, as a Category 4 hurricane. The storm brought heavy winds and rain to southeast Louisiana, breaching several levees and flooding up to 80 percent of New Orleans and large areas of coastal Louisiana. Much of the area that was flooded during Hurricane Katrina was flooded again by the storm surge from Hurricane Rita. Both Hurricanes Katrina and Rita have caused a significant amount of change in sedimentation and water quality in southern Louisiana. Many wastewater treatment facilities were temporarily or permanently damaged. Some wastewater treatment facilities will be rebuilt while others will be relocated. The hurricanes expedited the loss of coastal land and modified the hydrology of some of the coastal waterbodies. Several federal and state agencies including EPA and LDEQ are engaged in collecting environmental data and assessing the recovery of the Gulf of Mexico waters. The proposed TMDLs in this report were developed using pre-hurricane conditions. Therefore, post-hurricane conditions and other factors could delay the implementation of these proposed TMDLs, render some proposed TMDLs obsolete, or could require modifications of the TMDLs.

Much of coastal Louisiana was built by the process of delta formation through flooding and deposition of sediments by the rise and fall of the Mississippi River. According to EPA's present knowledge, extensive areas of wetlands and coastal marshes are affected by a high rate of subsidence and degradation, primarily due to a lack of historical sediment and nutrients entering the wetlands. Subsidence is a natural process, but the building of levee systems has restricted the Mississippi River's course and, therefore, is preventing the natural cycle of the river and the natural process of delta formation. According to EPA, a large portion of the state's coastal wetlands have undergone and continue to undergo severe deprivation of sediments and nutrients that has led to the breakup of the natural system. In addition, EPA believes that many of Louisiana's wetlands have become isolated from the riverine sources that created them and are becoming stagnant and starved for nutrients and organic and inorganic sediments. Note that restoring these eroding wetlands involves supplying nutrients to these areas through managed Mississippi River diversions.

On the basis of EPA's understanding, if any future diversion from the Mississippi River or other tributaries will increase flow, the nonpoint source load allocation and TMDLs will also be increased proportionately. From EPA's current understanding, the diversion projects are supported by both state and federal agencies, including EPA and the U.S. Army Corps of Engineers (USACE). The diversions are managed by the USACE and the state, and the projects include post-diversion monitoring to determine effectiveness of the project and to monitor water quality conditions.

Wasteload Allocation

The WLA portion of the TMDL equation is the total loading of a pollutant that is assigned to point sources. The point sources in the Terrebonne River Basin include wastewater facilities and MS4s. Wasteload allocations are based on the current permit limits and discharge flow levels.

No domestic wastewater facilities with permit limits for chloride, sulfate, or TDS were found in the Terrebonne River Basin, although it is possible that the discharges from such facilities could have slightly elevated levels of these parameters. Therefore, these facilities were given WLAs using assumed effluent concentrations. From samples collected by LDEQ in field surveys from Cotton Valley Sewage Treatment Plant (STP), City of Minden trickling filter plant, City of Springhill STP, and City of Houma South Plant, median values of chloride (58 mg/L) and TDS (425 mg/L) concentrations in measured effluent were used in the calculations. For sulfate, 30 mg/L (Metcalf and Eddy 1991—a literature value for medium-strength domestic wastewater—was used. The median values for chloride and TDS derived from the field survey were similar to those in Metcalf and Eddy (1991); therefore, it was assumed that using the sulfate value from this study was appropriate.

For fecal coliform bacteria, LDEQ's policy is to set wastewater permit limits no higher than water quality criteria (i.e., criteria are met at end-of-pipe). As long as point source discharges of treated wastewater contain parameter levels at or below these permit limits, they should not be a cause of exceedances of the fecal coliform bacteria water quality criteria. Therefore, no change in the permit limits is required.

No nondomestic wastewater facilities with permit limits for chloride, sulfate, or TDS are in this subsegment. Therefore, it was assumed that none of these facilities have elevated concentrations and no WLAs were assigned. No wastewater facilities were included in the TMDL for TSS or turbidity because it appears that the only facilities that contribute to turbidity are small or remote and, therefore, are not significant.

Tables 4-6, 4-7, and 4-8 list the individual WLAs for each parameter and point source included in the Terrebonne River Basin TMDLs.

Table 4-6. Chloride WLAs for the Terrebonne River Basin

Permit number	Outfall	Flow (gpd)	Estimated chloride limit (mg/L)	Chloride WLA (kg/year)
Subsegment 120101				
LA0099210	1	5,000	58	1.10
LA0099210	2	6,000	58	1.32
LA0099210	3	6,000	58	1.32
LA0099210	4	6,000	58	1.32
LA0099210	5	6,000	58	1.32
LA0099210	6	9,000	58	1.98
Total				**8.34**

Table 4-7. Sulfate WLAs for the Terrebonne River Basin

Permit number	Outfall	Flow (gpd)	Estimated sulfate limit (mg/L)	Sulfate WLA (kg/year)
Subsegment 120201				
LAG540151	1	25,000	30	2.84
LAG540162	1	25,000	30	2.84
LAG540542	1	25,000	30	2.84
LAG560025	1	50,000	30	5.68
Total				**14.20**

Table 4-8. Fecal coliform bacteria WLAs for the Terrebonne River Basin

Permit number	Outfall	Flow (gpd)	Fecal coliform monthly avg. (colonies/100 mL)	Fecal coliform weekly avg. (colonies/100 mL)	Fecal coliform daily max. (colonies/100 mL)	Fecal load (1×10^6 colonies/day)[a]
Subsegment 120201						
LAG540151	1	25,000	200	400	--	189.25
LAG540162	1	25,000	200	400	--	189.25
LAG540542	1	25,000	200	400	--	189.25
LAG560025	1	50,000	200	400	--	378.50
Total						**946.25**
Subsegment 120206						
LAR00C088	101	300	--	--	400	4.54
LAR00C088	102	100	--	--	400	1.51
LAR00C088	103	750	--	--	400	11.36
LA0107212	2	150	--	400	--	2.27
LAG540036	1	25,000	200	400	--	189.25
LAG540548	1	25,000	200	400	--	189.25
LAG540954	1	25,000	200	400	--	189.25
LAG560026	1	50,000	200	400	--	378.50
WG020066	1	25,000	200	400	--	189.25
Total						**1,155.18**

Table 4-8. (continued)

Permit number	Outfall	Flow (gpd)	Fecal coliform monthly avg. (colonies/100 mL)	Fecal coliform weekly avg. (colonies/100 mL)	Fecal coliform daily max. (colonies/100 mL)	Fecal load (1×10^6 colonies/day)[a]
Subsegment 120301						
LA0100072	2	25,000	200	400	--	189.25
LAG530351	1	5,000	--	400	--	75.70
LA0072231	1	10,000	200	400	0	75.70
LAG530057	1	5,000	--	--	400	75.70
LAG540453	1	25,000	200	400	--	189.25
LAG530288	1	5,000	--	400	--	75.70
Total						**681.30**
Subsegment 120606						
LAG540455	--	25,000	200	400	--	189.25
LAG540458	--	25,000	200	400	--	189.25
LAG540460	--	25,000	200	400	--	189.25
Total						**567.75**

[a] Monthly average permit limits, when applicable, were used to calculate the load. When a permit does not have a monthly average permit limit, the weekly average permit limit was used. If the facility has neither a monthly nor a weekly limit, the daily maximum limit was used to calculate loads.

EPA's stormwater permitting regulations require municipalities to obtain permit coverage for all stormwater discharges from MS4s. For each MS4 in the basin, a gross MS4 load was computed by multiplying the LA by the ratio of the MS4 area in each subsegment to the subsegment area. Note that these values are estimates that can be refined in the future as more information about the MS4s and land use-specific loadings information becomes available. Note also that the MS4 loads presented reflect only that portion of the MS4 in the subsegment. The computed MS4 load was subtracted from the LA and included as a WLA component of the TMDL because MS4s are permitted dischargers but function similarly to nonpoint sources through storm-driven processes. Table 4-9 lists the individual WLAs for the MS4s identified in Section 2.6.

Table 4-9. WLAs for the MS4s in the Terrebonne River Basin

Subsegment number	Subsegment name	Urban area	MS4 area (acres)	Subsegment area (acres)	Season	MS4 WLA (1×10^9 colonies/day)
120109	Intracoastal Waterway	Baton Rouge	40	3,805	Summer	1.54
					Winter	2.99
120301	Bayou Terrebonne	Houma	1,448	3,279	Summer	87.11
					Winter	1,972.34
120503	Bayou Petit Caillou	Houma	57	290	Year Round	0.06
120504	Bayou Petit Caillou	Houma	260	877	Year Round	0.23
120507	Bayou Chauvin	Houma	166	2,595	Summer	12.04
					Winter	11.77
120602	Bayou Terrebonne	Houma	64	477	Year Round	0.08
120605	Bayou Pointe au Chien	Houma	28	2,601	Summer	0.99
					Winter	0.65

Load Allocation

The load allocation is the portion of the TMDL assigned to natural background conditions as well as nonpoint sources such as septic tank leakage, wildlife, and agricultural practices. For this TMDL, that LA was calculated by subtracting the WLA and MOS from the total TMDL. LAs were not allocated to separate nonpoint sources due to the lack of available source characterization data. LAs are presented in Tables 4-3, 4-4, and 4-5.

4.3 Seasonality and Critical Conditions

The federal regulations at 40 CFR 130.7 require that TMDLs include seasonal variations and take into account critical conditions for streamflow, loading, and water quality parameters. For this TMDL, fecal coliform bacteria loadings for subsegments with primary contact recreation as the designated use were determined for winter and summer on the basis of seasonal water quality criteria, thus accounting for seasonality. In addition, the sampling results for all pollutants were plotted over time and reviewed for any seasonal patterns (see Section 3.2). The water quality criteria for fecal coliform bacteria in subsegments designated for shellfish/oyster propagation and the other pollutants (chloride, sulfate, TDS, sediment, TSS, and turbidity) are applied all year, and the TMDLs were developed over a several-year time period, therefore, accounting for seasonal variations.

For fecal coliform bacteria, the water quality criteria include values that must not be exceeded more than 25 percent of the time (primary and secondary contact recreation) and 10 percent of the time (shellfish/ oyster propagation) on the basis of the data sampled throughout the year, including during critical and noncritical conditions.

4.4 Margin of Safety

MOS is the portion of the pollutant loading reserved to account for any uncertainty in the data. There are two ways to incorporate the MOS (USEPA 1991). One way is to implicitly incorporate the MOS by using conservative model assumptions to develop allocations. The other way is to explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations. For all pollutants except turbidity, TSS, and sediment in this analysis, the MOS is explicit: 10 percent of each targeted TMDL was reserved as the MOS to account for any uncertainty in the TMDL. Using 10 percent of the TMDL load provides an additional level of protection to the designated uses of the subsegments of concern. For the turbidity TMDL, an implicit MOS was incorporated by using conservative assumptions. The primary conservative assumption was calculating the turbidity TMDLs assuming that TSS is a conservative parameter and does not settle out of the water column.

4.5 Future Growth

While the MOS is an allocation for scientific uncertainly, future growth is an allocation for growth. Ten percent of the load was allocated for future growth in the area that is covered by the TMDL. This includes future urban development, including point sources and MS4 areas, and agricultural and other typical nonpoint source contributing areas.

5 FUTURE WATERSHED ACTIVITIES

5.1 TMDL Implementation Strategies

Wasteload allocations will be implemented through Louisiana Pollutant Discharge Elimination System (LPDES) permit procedures.

Load allocations will be addressed through the LDEQ Nonpoint Source Management Program. Louisiana's *Nonpoint Source Management Plan* (LDEQ 2000) states that TMDLs are being developed through a close relationship between LDEQ and EPA Region 6. It further states that "management strategies outlined within this document (both statewide and watershed) will be implemented in each of the watersheds where water quality problems have been attributed to nonpoint sources of pollution." On page ii, Objective 3 of the watershed management strategies is to "utilize pollutant load reductions of the TMDL to develop nonpoint source pollution reduction strategies for each of the watersheds...that have water quality problems identified." In addition, Objective 7 provides a tracking process for evaluating progress in reducing loadings of fecal coliform bacteria.

The plan includes a discussion of a number of nonpoint source activities and provides best management practices (BMPs) that can be used to achieve the nonpoint source load reductions established in the TMDLs. The plan broadly discusses programs to address agriculture, forestry, home sewer treatment systems, hydromodification, urban runoff, construction, and resource extraction. Provided with each BMP is an evaluation of the effectiveness of the BMP, given as a high, medium, or low ranking. Additional evaluations should be conducted to determine the most likely source of impairment in this watershed and to identify localized hot spots to be targeted for effective BMP implementation. These and other BMPs may be implemented at a scale adequate to achieve the load reductions established in the TMDL.

5.2 Water Quality Monitoring Activities

LDEQ uses funds provided under section 106 of the federal Clean Water Act and under the authority of the Louisiana Environmental Quality Act to run a program for monitoring the quality of the state's surface waters. The LDEQ Surveillance Section collects surface water samples at various locations using appropriate sampling methods and procedures to ensure the quality of the data collected. The objectives of the surface water monitoring program are to determine the quality of the state's surface waters, develop a long-term database for water quality trend analysis, and monitor the effectiveness of pollution controls. The data obtained through the surface water monitoring program are used to develop the state's biennial section 305(b) report (*Water Quality Inventory*) and the section 303(d) list of impaired waters. This information is also used in establishing priorities for LDEQ's nonpoint source program.

LDEQ has implemented a watershed approach to surface water quality monitoring. Through this approach, the entire state is sampled on a 4-year cycle. Long-term trend monitoring sites at various locations on the larger rivers and Lake Pontchartrain are sampled throughout the 4-year cycle. Sampling is conducted monthly to yield approximately 12 samples per site during each year the site is monitored. Sampling sites are located where they are considered to be representative of the waterbody. Under the current monitoring schedule, approximately one-half of the state's waters are newly assessed for section 305(b) and section 303(d) listing purposes for each biennial cycle, with sampling occurring statewide each year. The 4-year cycle follows an initial 5-year rotation that covered all basins in the state according to the TMDL priorities. Monitoring will allow LDEQ to determine whether there has been any improvement in water quality following implementation of the TMDLs. As the monitoring results are evaluated at the end of each year, waterbodies may be added to or removed from the section 303(d) list of impaired waterbodies.

6 PUBLIC PARTICIPATION

Federal regulations require EPA to notify the public and seek comment concerning TMDLs that the Agency prepares. This TMDL was developed under contract to EPA, and EPA is seeking comments, information, and data from the public and any other interested party. Comments and additional information submitted during this public comment period will be used to inform or revise this TMDL. The comments and responses will be included in an appendix in the final draft of this TMDL. EPA will submit the final TMDL to LDEQ for implementation and incorporation into LDEQ's current water quality management plan.

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Appendix A
Summary of Water Quality Data

Table A-1. Fecal coliform bacteria data summary for the Terrebonne River Basin (primary contact recreation)

Station number	Station name	Period of record	Number of observations	Minimum MPN/ 100ml	Maximum MPN/ 100ml	Mean MPN/ 100ml	Median MPN/ 100ml	Number of observations above criterion[a]	% of observations above criterion[a]
May 1 through October 31									
Subsegment 120101									
968	Bayou Portage, LA	5/30/00–10/24/00	6	700	16,000	5,167	4,000	6	100%
Subsegment 120102									
969	Bayou Poydras, LA	5/30/00–10/24/00	6	40	9,000	1,653	150	2	33%
Subsegment 120104									
335		No Data							
970	Bayou Grosse Tete, LA	5/30/00–10/24/00	6	130	2,400	728	300	2	33%
Subsegment 120105									
971	Chamberlin Canal, LA	5/30/00–10/24/00	6	50	9,000	2,453	295	3	50%
Subsegment 120109									
80	Lower Grand River at Bayou Sorrel, LA	5/8/78–5/11/98	108	10	16,000	656	195	34	31%
417	Bayou Plaquemine at Grand River, LA	No Data							
975	Intracoastal Waterway near Indian Village, LA	5/30/00–10/24/00	6	4	80	35	30	0	0%
Subsegment 120111									
977	Bayou Maringouin, LA	5/30/00–10/24/00	6	110	3,000	1,282	650	4	67%

Table A-1. (continued)

Station number	Station name	Period of record	Number of observations	Minimum MPN/ 100ml	Maximum MPN/ 100ml	Mean MPN/ 100ml	Median MPN/ 100ml	Number of observations above criterion[a]	% of observations above criterion[a]
Subsegment 120112									
978	Bayou Fordoche, LA	5/30/00–10/24/00	6	110	9,000	1,953	600	4	67%
Subsegment 120201									
337	Belle River north of Morgan City, LA	5/13/91–5/11/98	19	20	230	87	70	0	0%
979	Lower Grand River, LA	5/30/00–10/24/00	6	80	1,600	467	225	2	33%
Subsegment 120206									
82	Grand Bayou at Grand Bayou, LA	5/10/78–5/11/98	85	10	16,000	1,036	130	25	29%
980	Grand Bayou, LA	5/9/00–10/25/00	7	23	300	108	50	0	0%
Subsegment 120301									
110	Bayou Terrebonne at Houma, LA	6/12/78–10/25/00	94	17	350,000	16,403	3,000	80	85%
Subsegment 120507									
345	Bayou Chauvin near Houma, LA	6/10/91–10/13/97	20	10	16,000	1,248	120	6	30%

Table A-1. (continued)

Station number	Station name	Period of record	Number of observations	Minimum MPN/ 100ml	Maximum MPN/ 100ml	Mean MPN/ 100ml	Median MPN/ 100ml	Number of observations above criterion[a]	% of observations above criterion[a]
Subsegment 120605									
946	Bayou Point aux Chene east of Montegut, LA	6/20/00–10/17/00	5	4	2,400	606	110	2	40%
Subsegment 120606									
947	Forty Arpent Canal in Cutoff, LA	5/2/00–10/24/00	7	23	800	224	50	2	29%
2844	Bayou Blue south of Larose, LA	No Data							
November 1 through April 30									
Subsegment 120101									
968	Bayou Portage, LA	1/4/00–2/3/04	6	188	16,000	7,531	5,700	4	67%
Subsegment 120102									
969	Bayou Poydras, LA	1/4/00–2/3/04	7	27	1,700	1,096	1,400	0	0%
Subsegment 120104									
335		No Data							
970	Bayou Grosse Tete, LA	1/4/00–2/3/04	7	300	1,700	971	900	0	0%
Subsegment 120105									
971	Chamberlin Canal, LA	1/4/00–2/3/04	7	26	16,000	2,479	220	1	14%

Table A–1. (continued)

Station number	Station name	Period of record	Number of observations	Minimum MPN/ 100ml	Maximum MPN/ 100ml	Mean MPN/ 100ml	Median MPN/ 100ml	Number of observations above criterion[a]	% of observations above criterion[a]
Subsegment 120109									
80	Lower Grand River at Bayou Sorrel, LA	11/13/78–4/13/98	106	20	16,000	964	330	12	11%
417	Bayou Plaquemine at Grand River, LA	No Data							
975	Intracoastal Waterway near Indian Village, LA	1/4/00–2/3/04	7	30	1,600	379	260	0	0%
Subsegment 120111									
977	Bayou Maringouin, LA	1/4/00–2/3/04	7	30	16,000	2,420	240	1	14%
Subsegment 120112									
978	Bayou Fordoche, LA	1/4/00–2/3/04	7	58	16,000	5,311	1,700	3	43%
Subsegment 120201									
337	Belle River north of Morgan City, LA	1/14/91–3/9/98	23	20	1,300	304	170	0	0%
979	Lower Grand River, LA	1/4/00–2/3/04	7	110	1,700	713	240	0	0%

Table A-1. (continued)

Station number	Station name	Period of record	Number of observations	Minimum MPN/ 100ml	Maximum MPN/ 100ml	Mean MPN/ 100ml	Median MPN/ 100ml	Number of observations above criterion[a]	% of observations above criterion[a]
Subsegment 120206									
82	Grand Bayou at Grand Bayou, LA	4/12/78–3/9/98	89	10	24,000	2,484	330	16	18%
980	Grand Bayou, LA	1/11/00–11/29/00	5	50	1,300	458	300	0	0%
Subsegment 120301									
110	Bayou Terrebonne at Houma, LA	11/13/78–3/9/04	98	50	2,400,000	44,416	1,700	46	47%
Subsegment 120507									
345	Bayou Chauvin near Houma, LA	2/4/91–4/13/98	22	10	5,000	856	300	4	18%
346	Bayou Chauvin south of Houma, LA	1/14/91–3/22/04	30	2	2,400	436	225	2	7%
Subsegment 120605									
946	Bayou Point aux Chene east of Montegut, LA	1/25/00–12/19/00	6	70	500	282	255	0	0%
Subsegment 120606									
947	Forty Arpent Canal in Cutoff, LA	1/4/00–11/28/00	5	22	300	175	230	0	0%
2844	Bayou Blue south of Larose, LA	1/12/04–2/9/04	2	27	110	68.5	68.5	0	0%

[a] Primary contact recreation water quality criteria for fecal coliform bacteria: No more than 25 percent of the total samples collected on a monthly or near-monthly basis shall exceed a fecal coliform bacteria density of 400 colonies/100 mL from May 1 through October 31. During the non-recreational period of November 1 through April 30, the criteria for secondary contact recreation shall apply (no more than 25 percent of the total samples collected on a monthly or near-monthly basis shall exceed a fecal coliform bacteria density of 2,000 colonies/100 mL).

Table A-2. Summary of fecal coliform bacteria data for the Terrebonne River Basin (oyster propagation)

Station number	Station name	Period of record	Number of observations	Minimum MPN/ 100 ml	Maximum MPN/ 100 ml	Mean MPN/ 100 ml	Median MPN/ 100 ml	Number of observations above criterion[a]	% of observations above criterion[a]
Subsegment 120502									
113	Bayou Grand Caillou at Dulac, LA	5/9/78–12/12/00	167	10	24,000	870	330	156	93%
348	Bayou Grand Caillou south of Houma, LA	1/14/91–3/14/95	25	40	3,000	544	220	24	96%
Subsegment 120503									
939	Bayou Petit Caillou at Klondyke Bridge, LA	1/25/00–12/19/00	11	50	800	268	300	11	100%
Subsegment 120504									
347	Bayou Petite Caillou south of Houma, LA	3/12/91–12/19/00	54	20	5,000	633	300	49	91%
Subsegment 120506									
941	Bayou Du Large at Fishermans Retreat Bridge, LA	1/18/00–12/12/00	12	23	500	188	125	10	83%

Table A-2. (continued)

Station number	Station name	Period of record	Number of observations	Minimum MPN/ 100 ml	Maximum MPN/ 100 ml	Mean MPN/ 100 ml	Median MPN/ 100 ml	Number of observations above criterion[a]	% of observations above criterion[a]
Subsegment 120508									
344	Houma Navigation Canal south of Houma, LA	1/14/91–12/12/00	53	2	2,400	122	40	19	36%
Subsegment 120602									
349	Bayou Terrebonne southeast of Houma, LA	1/15/91–12/19/00	56	20	16,000	882	265	52	93%
Subsegment 120701									
351	Caillou Lake south of Houma, LA	6/10/91–4/14/98	41	20	800	41	20	2	5%
948	Bayou Grand Caillou at China Island, LA	1/25/00–12/19/00	10	2	17	4	2	0	0%
Subsegment 120703									
350	Bayou Dularge south of Houma, LA	2/4/91–4/14/98	42	20	3,000	341	230	36	86%
950	Grand Bayou Du Large at Bayou Voisin, LA	1/25/00–12/19/00	11	2	21	4	2	0	0%

Table A-2. (continued)

Station number	Station name	Period of record	Number of observations	Minimum MPN/ 100 ml	Maximum MPN/ 100 ml	Mean MPN/ 100 ml	Median MPN/ 100 ml	Number of observations above criterion[a]	% of observations above criterion[a]
Subsegment 120707									
954	Lake Boudreaux south of Bayou Chauvin, LA	1/19/00–2/16/04	14	4	500	88	40	7	50%
Subsegment 120708									
955	Lost Lake west of Bayou De Cade, LA	1/12/00–2/3/04	14	2	500	97	65	9	64%

[a] Criteria for oyster propagation: The fecal coliform bacteria median most probable number (MPN) shall not exceed 14 colonies/100 mL, and not more than 10 percent of the samples shall exceed an MPN of 43 colonies/100 mL for a five tube decimal dilution test in those portions of the area most probably exposed to fecal contamination during the most unfavorable hydrographic and pollution conditions.

Table A-3. Summary of chloride data for the Terrebonne River Basin

Station number	Station name	Period of record	Number of observations	Minimum (mg/L)	Maximum (mg/L)	Mean (mg/L)	Median (mg/L)	Number of observations above criterion[a]	% of observations above criterion[a]
Subsegment 120101									
968	Bayou Portage, LA	2/1/00–4/20/04	15	7.7	53.6	28	28.3	9	60%

[a] Chloride criterion for subsegment 120101 is 25 mg/L.

Table A-4. Summary of sulfate data for the Terrebonne River Basin

Station number	Station name	Period of record	Number of observations	Minimum (mg/L)	Maximum (mg/L)	Mean (mg/L)	Median (mg/L)	Number of observations above criterion[a]	% of observations above criterion[a]
Subsegment 120102									
969	Bayou Poydras, LA	2/1/00–4/13/04	15	11.2	428	195	176	13	87%
Subsegment 120110									
976	Bayou Chalpin, LA	2/1/00–4/13/04	15	11.2	157	62	31.6	10	67%
Subsegment 120201									
337	Belle River north of Morgan City, LA	5/13/91–9/8/97	45	4	71.7	24.2	20.9	6	13%
979	Lower Grand River, LA	2/1/00–4/13/04	16	17.1	71.9	43.4	45	10	63%

[a] Water Quality Criteria:
Subsegment 120102: 75 mg/L
Subsegment 120110: 25 mg/L
Subsegment 120201: 40 mg/L

Table A-5. Summary of TDS data for the Terrebonne River Basin

Station number	Station name	Period of record	Number of observations	Minimum (mg/L)	Maximum (mg/L)	Mean (mg/L)	Median (mg/L)	Number of observations above criterion[a]	% of observations above criterion[a]
Subsegment 120101									
968	Bayou Portage, LA	2/1/00–4/20/04	15	187	596	338	348	14	93%
Subsegment 120102									
969	Bayou Poydras, LA	2/1/00–4/13/04	15	156	888	532	498	6	40%
Subsegment 120104									
335		No Data							
970	Bayou Grosse Tete, LA	2/1/00–4/13/04	15	169	296	230	218	10	67%
Subsegment 120110									
976	Bayou Chalpin, LA	2/1/00–4/13/04	15	167	450	322	282	14	93%
Subsegment 120111									
977	Bayou Maringouin, LA	2/1/00–4/13/04	15	163	544	283	278	12	80%
Subsegment 120112									
978	Bayou Fordoche, LA	2/1/00–3/9/04	14	138	356	236	218.5	9	64%

[a] TDS criteria for all of the above segments is 200 mg/L, except for Subsegment 120102, which is 500 mg/L.

Table A-6. Summary of turbidity data for the Terrebonne River Basin

Station number	Station name	Period of record	Number of observations	Minimum NTU	Maximum NTU	Mean NTU	Median NTU	Number of observations above criterion[a]	% of observations above criterion[a]
Subsegment 120106									
972	Bayou Plaquemine, LA	2/1/00–4/13/04	15	26	100	56	50	0	0%

[a] Turbidity criterion for Subsegment 120106 is 150 NTU.

Table A-7. Summary of sediment and TSS data for the Terrebonne River Basin

Station number	Station name	Period of record	Number of observations	Minimum (mg/L)	Maximum (mg/L)	Mean (mg/L)	Median (mg/L)	Number of observations above criterion[a]	% of observations above criterion[a]
Subsegment 120101									
968	Bayou Portage, LA	2/1/00–4/20/04	15	12	770	115	82	1	7%
Subsegment 120102									
969	Bayou Poydras, LA	2/1/00–4/13/04	15	38.3	136	90	98	0	0%
Subsegment 120105									
971	Chamberlin Canal, LA	2/1/00–4/13/04	15	54	126	84	84	0	0%

[a] There are no numeric criteria for sediment or TSS, therefore TSS endpoints were calculated based on turbidity criteria for each listed subsegment. The calculated criteria were applied to segments listed for sediment and TSS. The calculated TSS criteria are as follows:

Subsegment 120101: 272 mg/L
Subsegment 120102: 210 mg/L
Subsegment 120105: 137 mg/L

Note: Subsegment 120101 is listed for TSS and subsegments 120102 and 120105 are listed for both sediment and TSS.

Appendix C
Fecal Coliform Bacteria Figures for Terrebonne River Basin

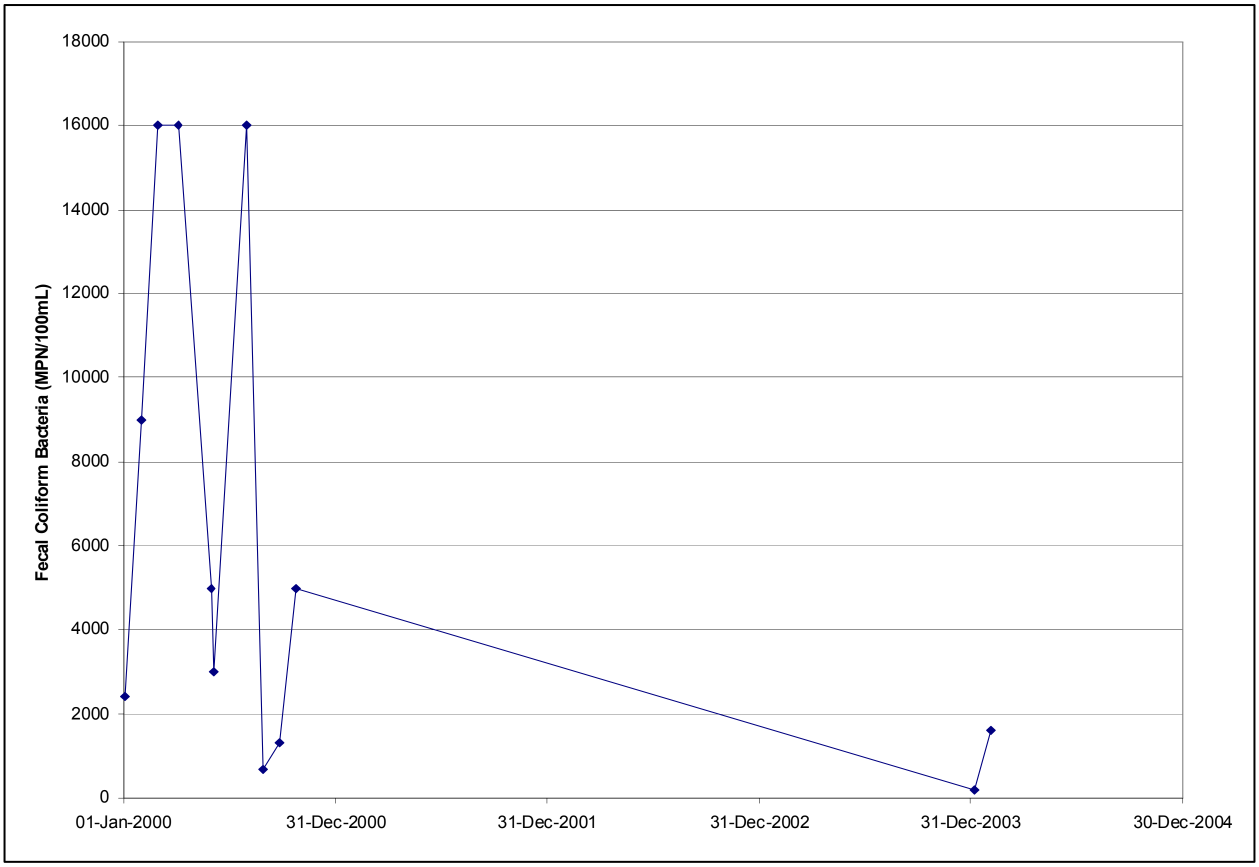

Figure C-1. Fecal coliform bacteria observations at Bayou Portage (subsegment 120101), Louisiana (station 968).

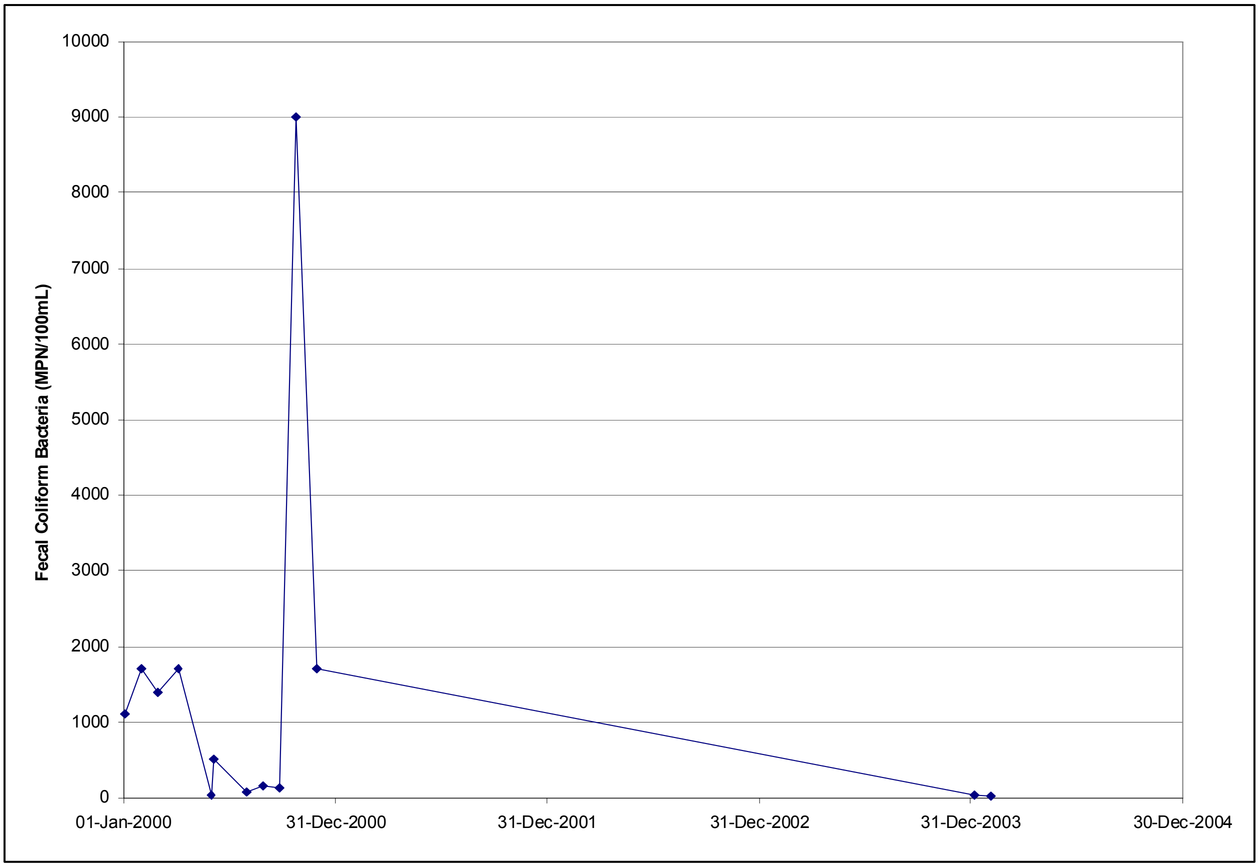

Figure C-2. Fecal coliform bacteria observations at Bayou Poydras (subsegment 120102), Louisiana (station 969).

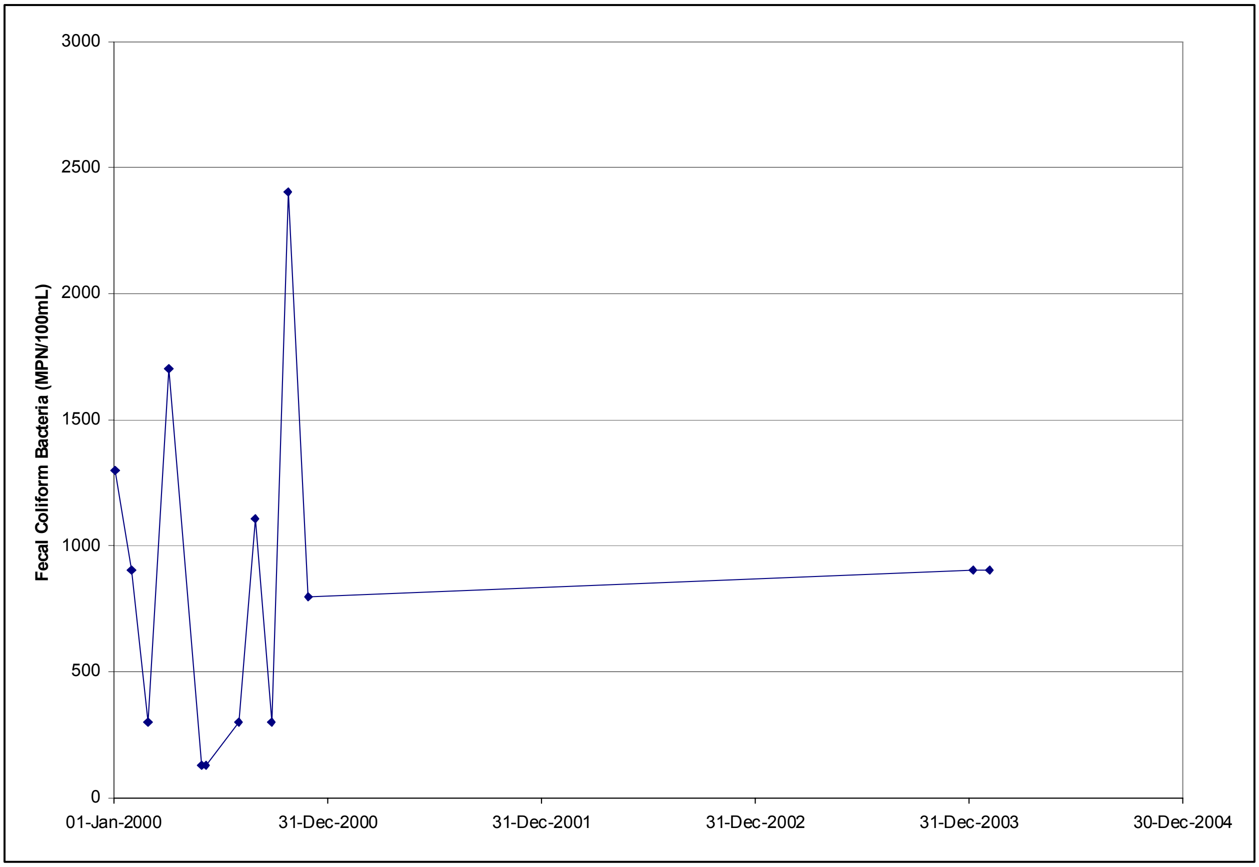

Figure C-3. Fecal coliform bacteria observations at Bayou Grosse Tete (subsegment 120104), Louisiana (station 970).

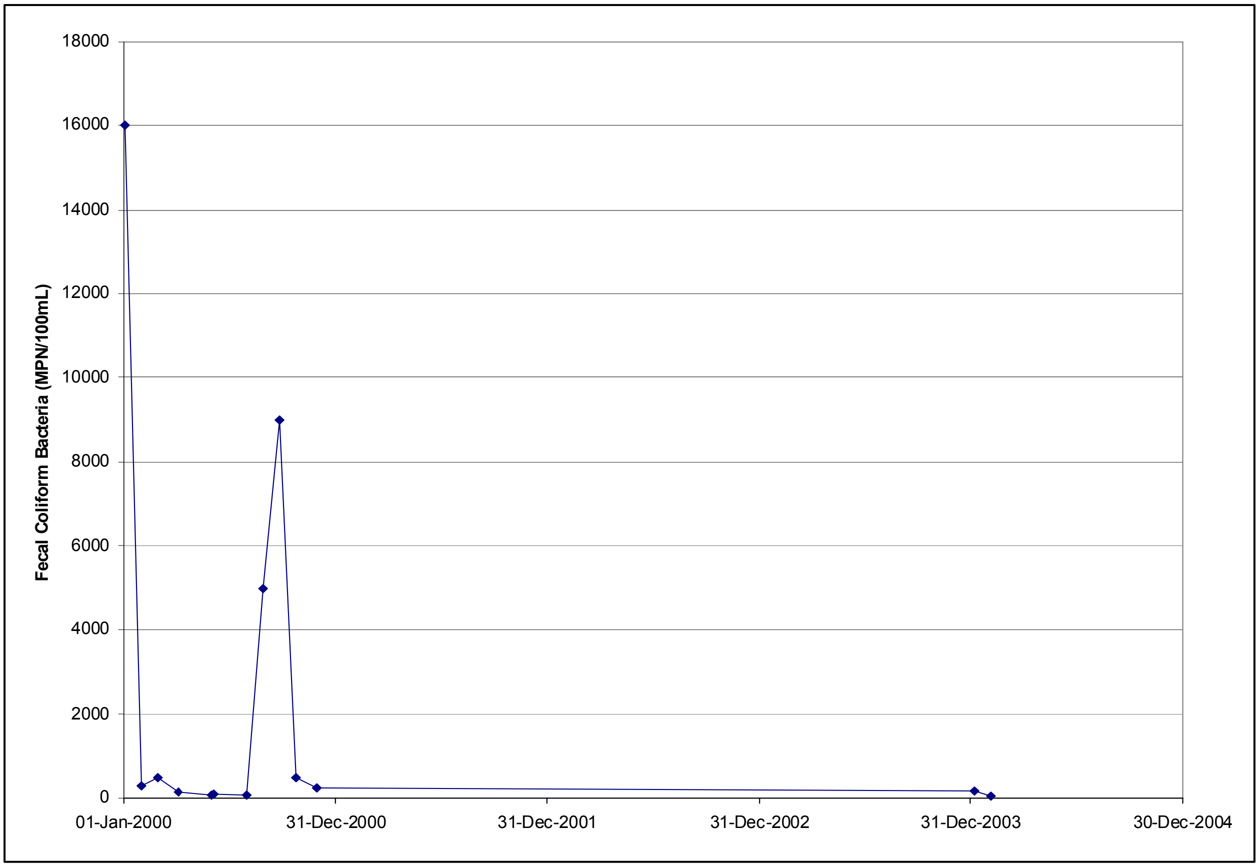

Figure C-4. Fecal coliform bacteria observations at Chamberlin Canal (subsegment 120105), Louisiana (station 971).

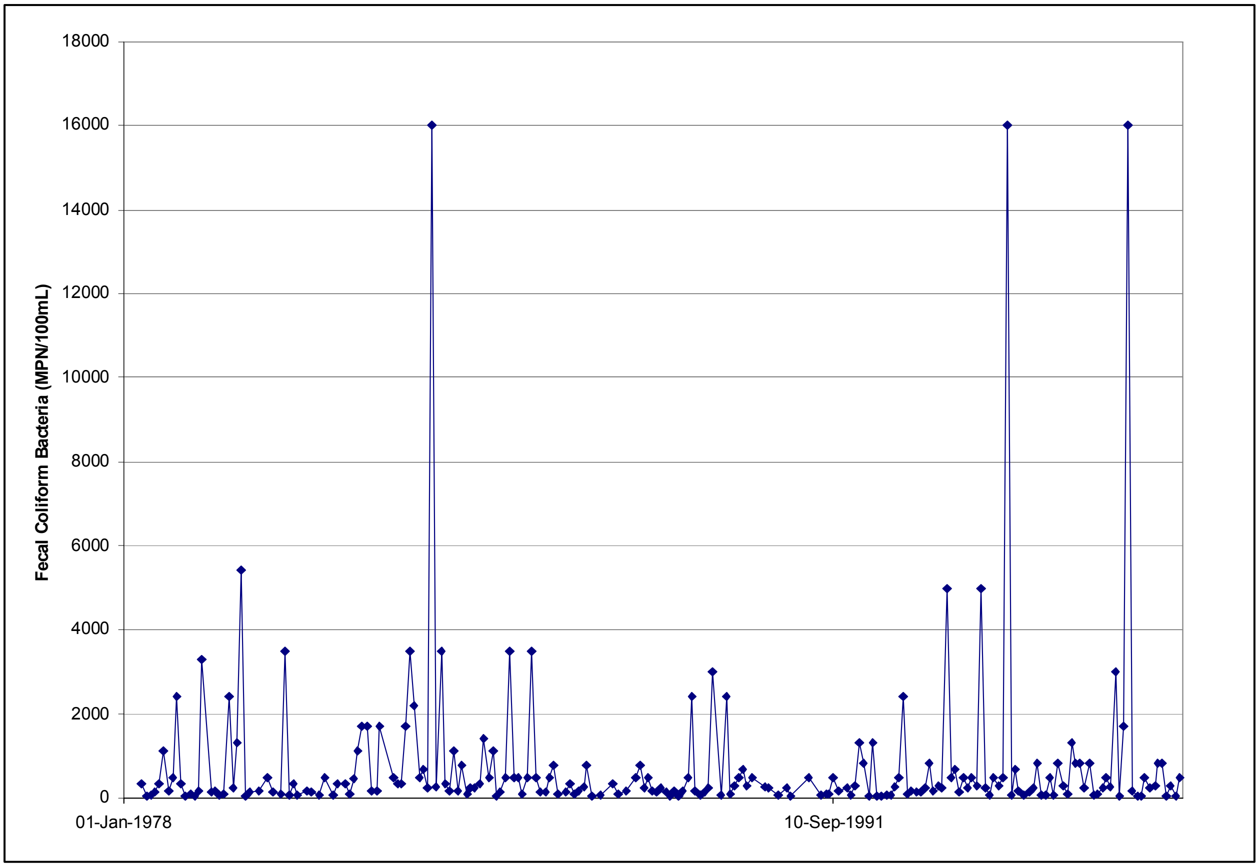

Figure C-5. Fecal coliform bacteria observations at Lower Grand River (subsegment 120109) at Bayou Sorrel, Louisiana (station 80).

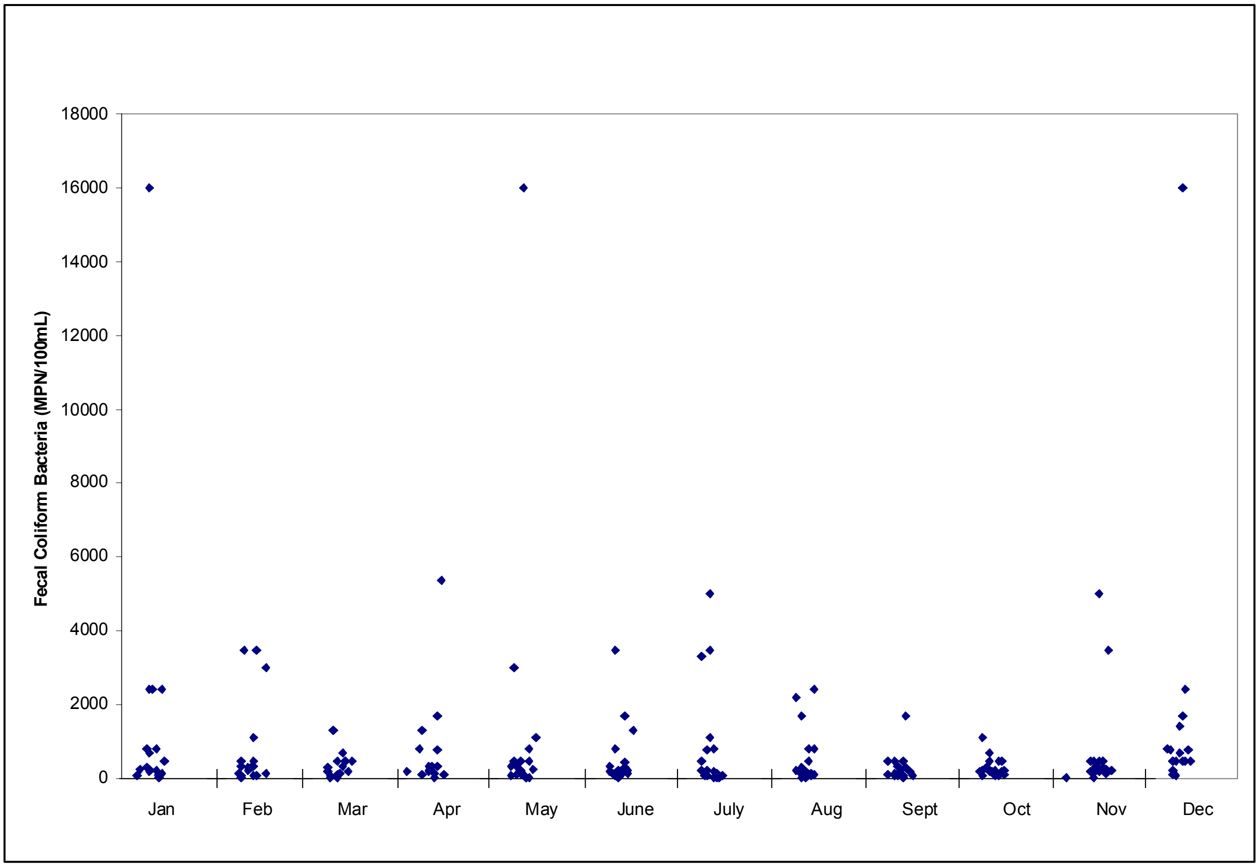

Figure C-6. Seasonal fecal coliform bacteria observations at Lower Grand River (subsegment 120109) at Bayou Sorrel, Louisiana (station 80).

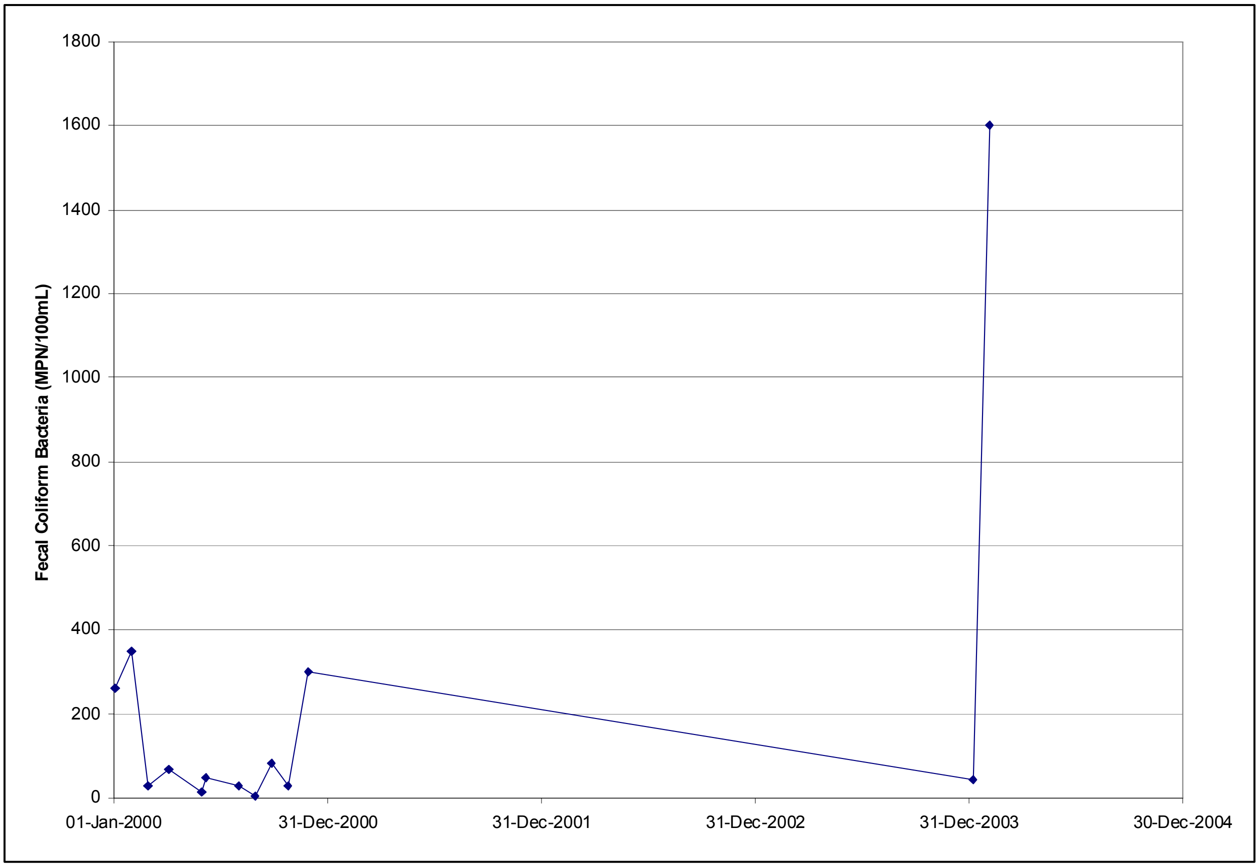

Figure C-7. Fecal coliform bacteria observations at Intracoastal Waterway (subsegment 120109) near Indian Village, Louisiana (station 975).

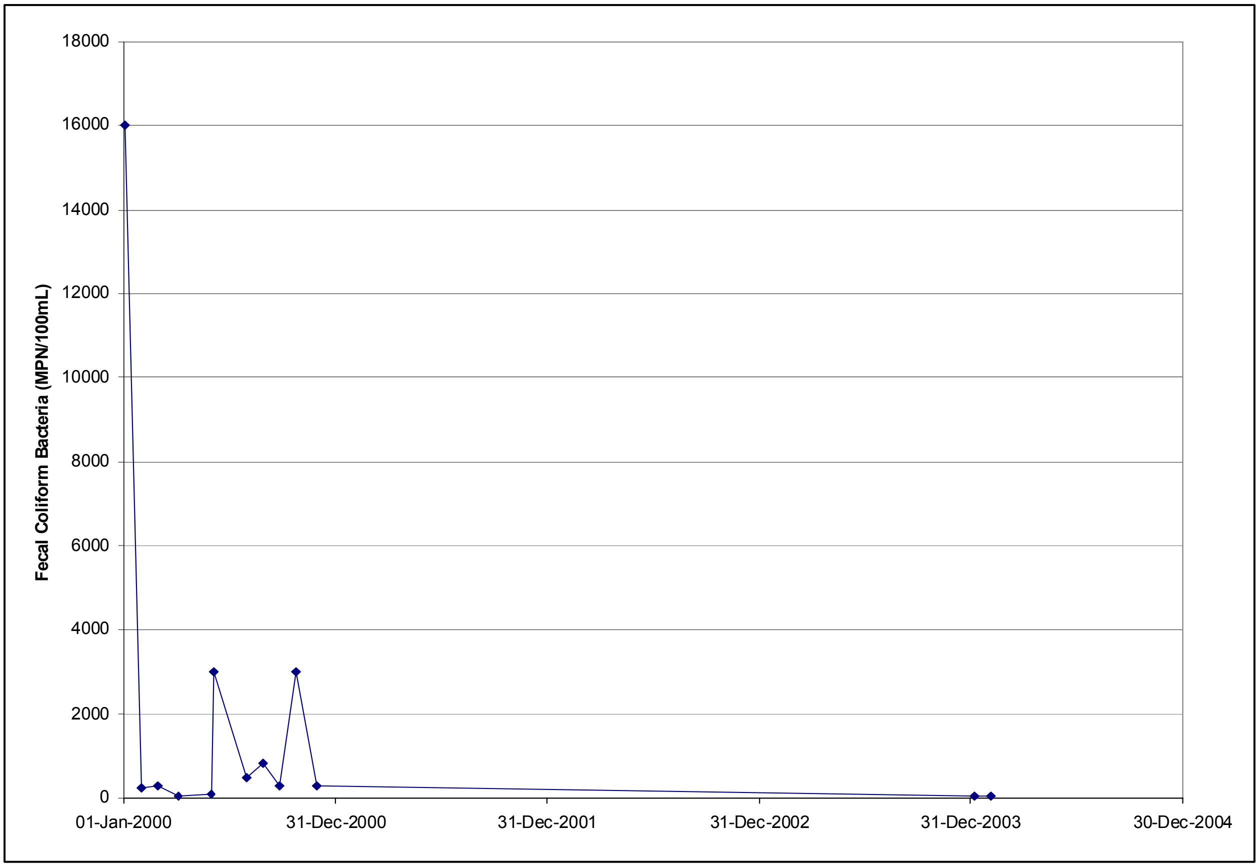

Figure C-8. Fecal coliform bacteria observations at Bayou Maringouin (subsegment 120111), Louisiana (station 977).

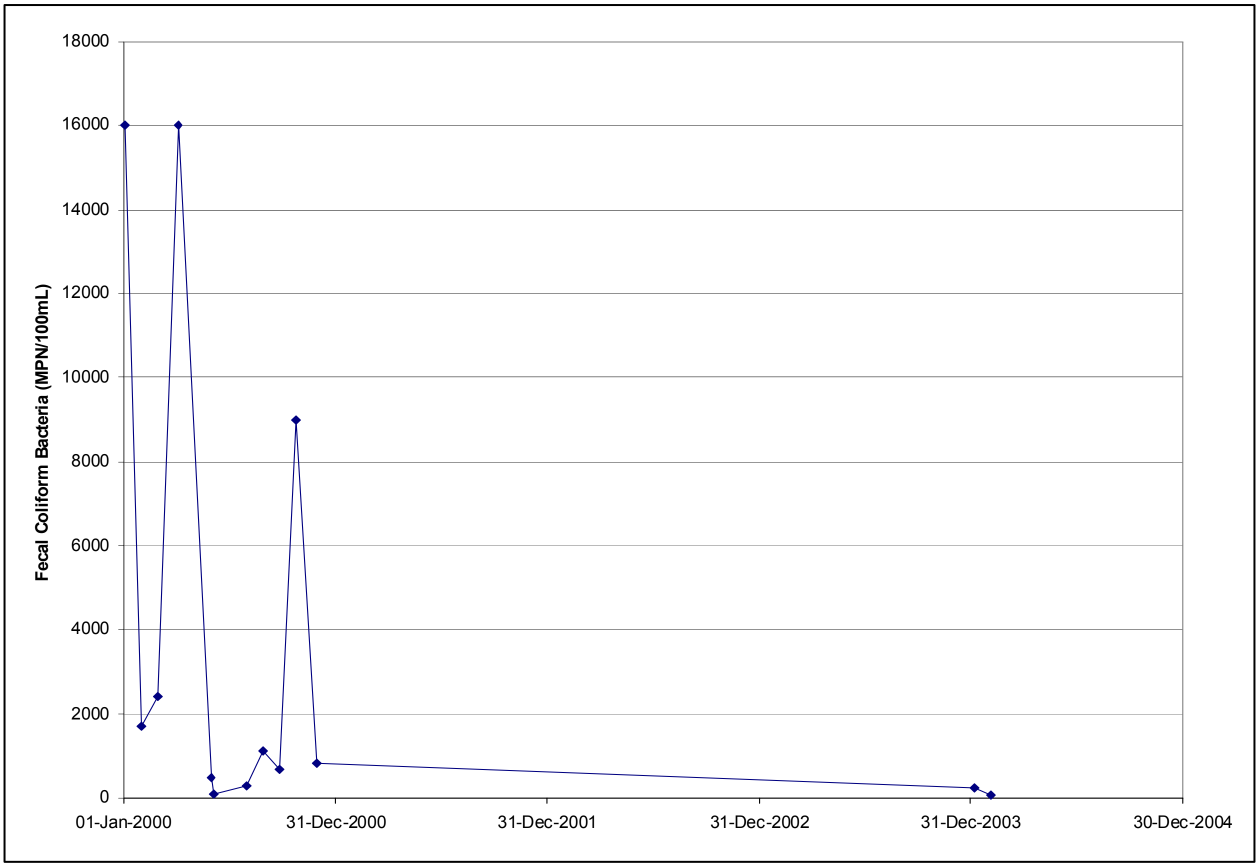

Figure C-9. Fecal coliform bacteria observations at Bayou Fordoche (subsegment 120112), Louisiana (station 978).

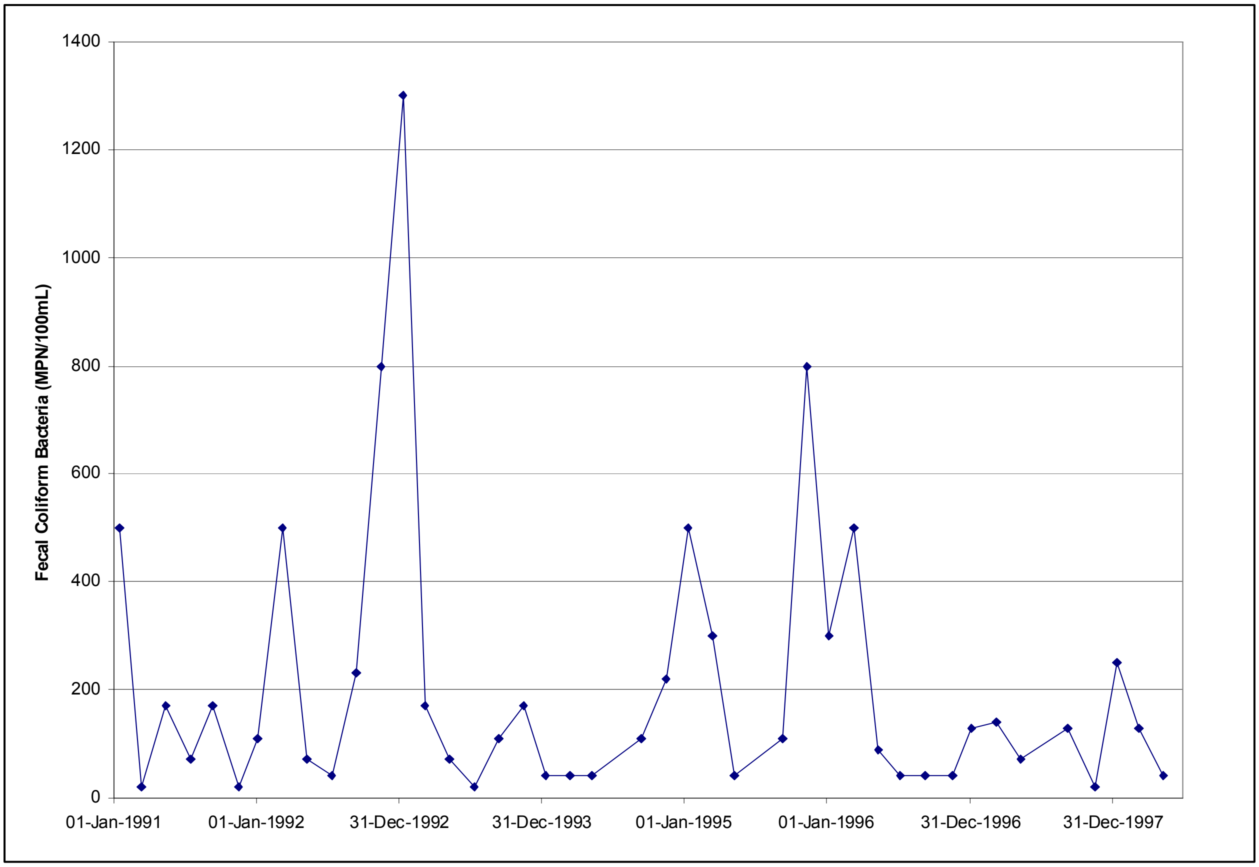

Figure C-10. Fecal coliform bacteria observations at Belle River (subsegment 120201) north of Morgan City, Louisiana (station 337).

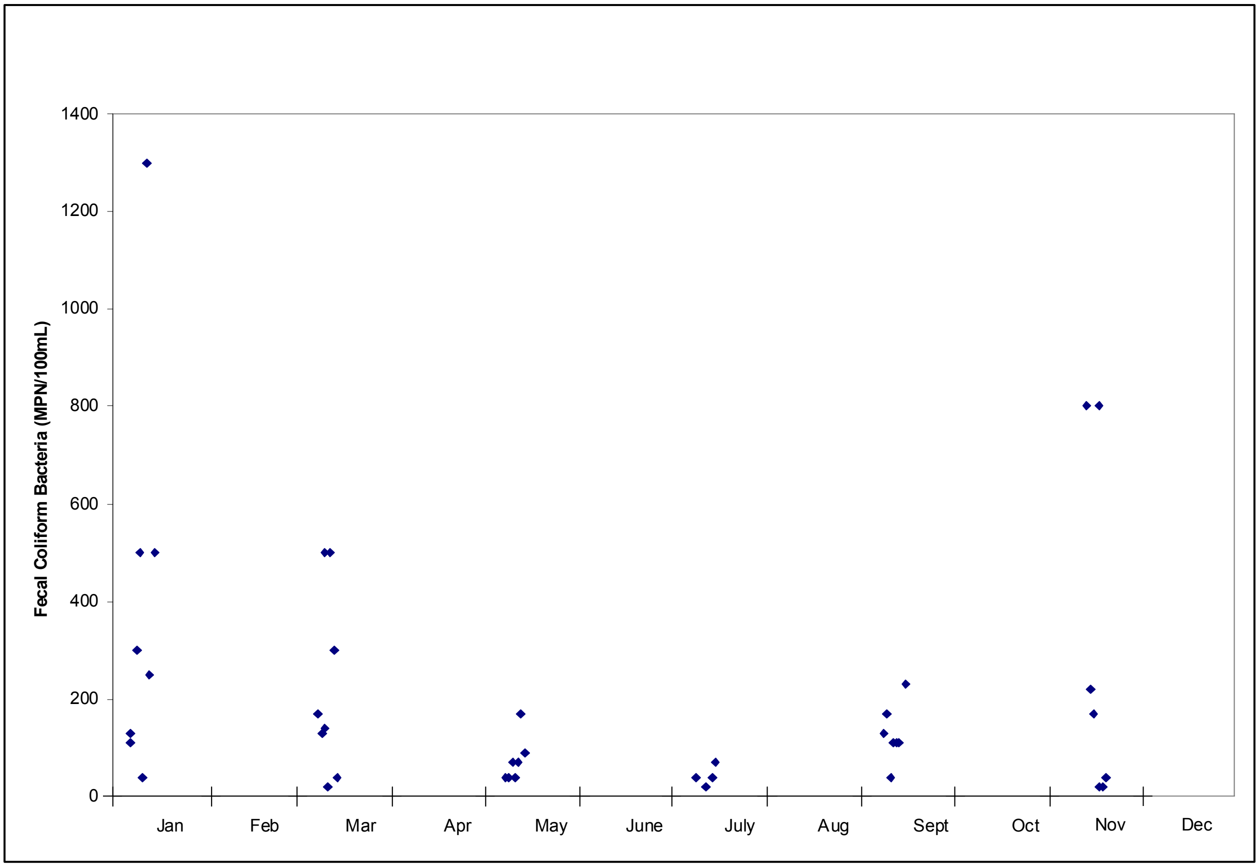

Figure C-11. Seasonal fecal coliform bacteria observations at Belle River (subsegment 120201) north of Morgan City, Louisiana (station 337).

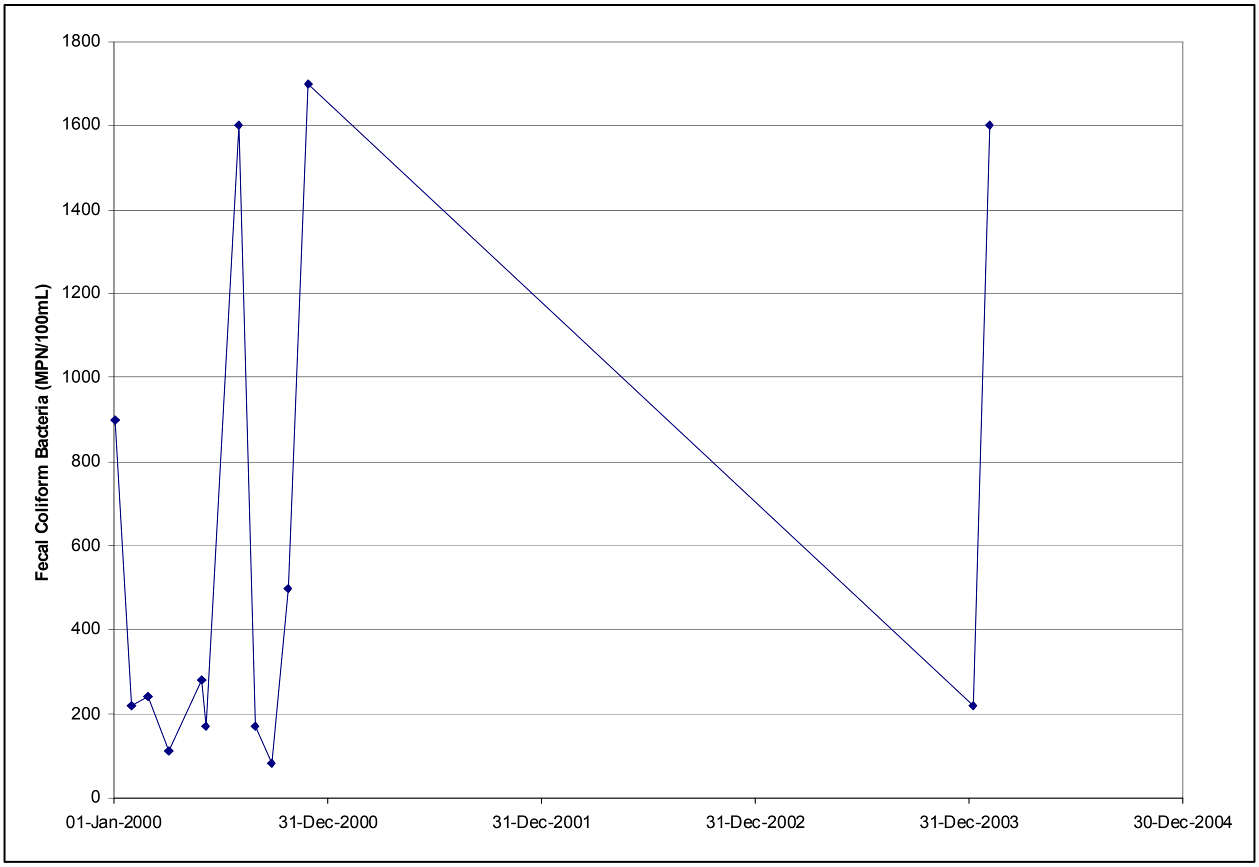

Figure C-12. Fecal coliform bacteria observations at Lower Grand River (subsegment 120201), Louisiana (station 979).

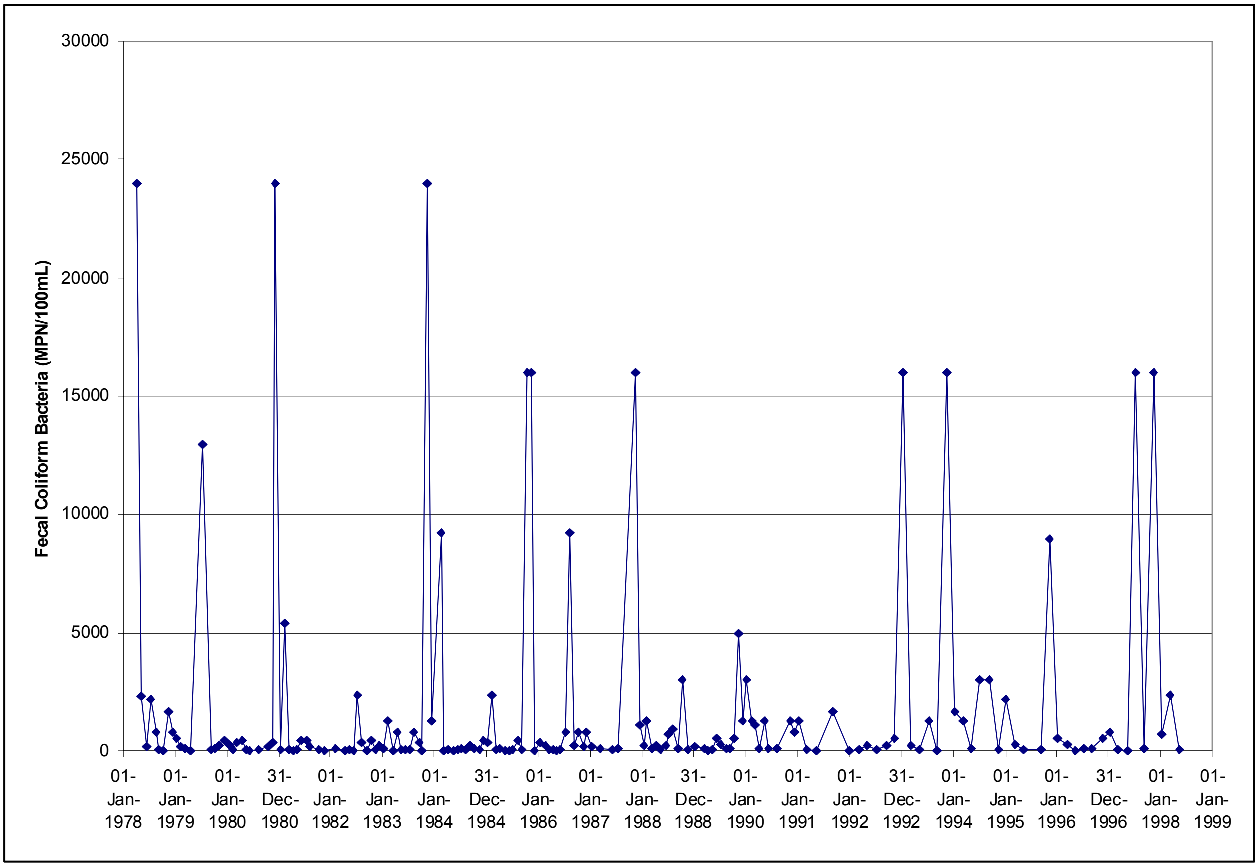

Figure C-13. Fecal coliform bacteria observations at Grand Bayou (subsegment 120206) at Grand Bayou, Louisiana (station 82).

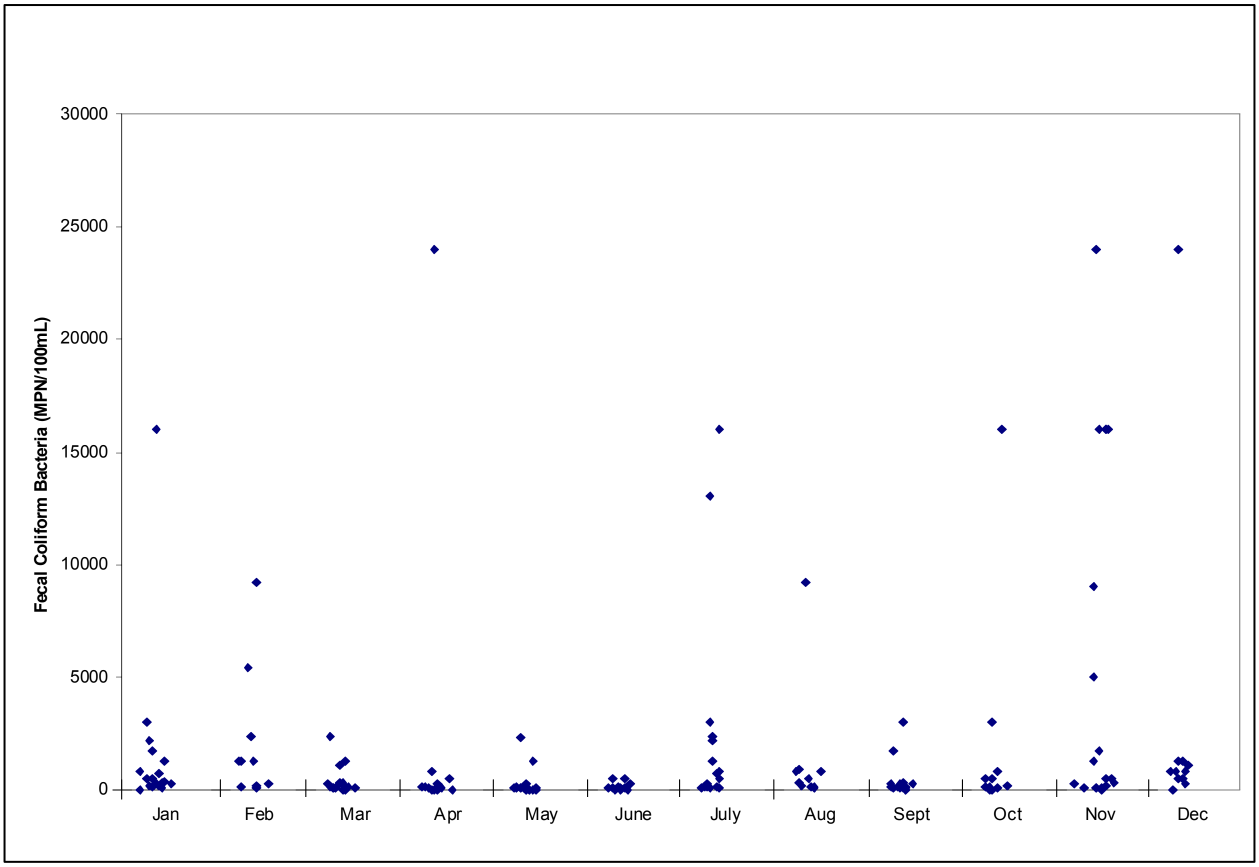

Figure C-14. Seasonal fecal coliform bacteria observations at Grand Bayou (subsegment 120206) at Grand Bayou, Louisiana (station 82).

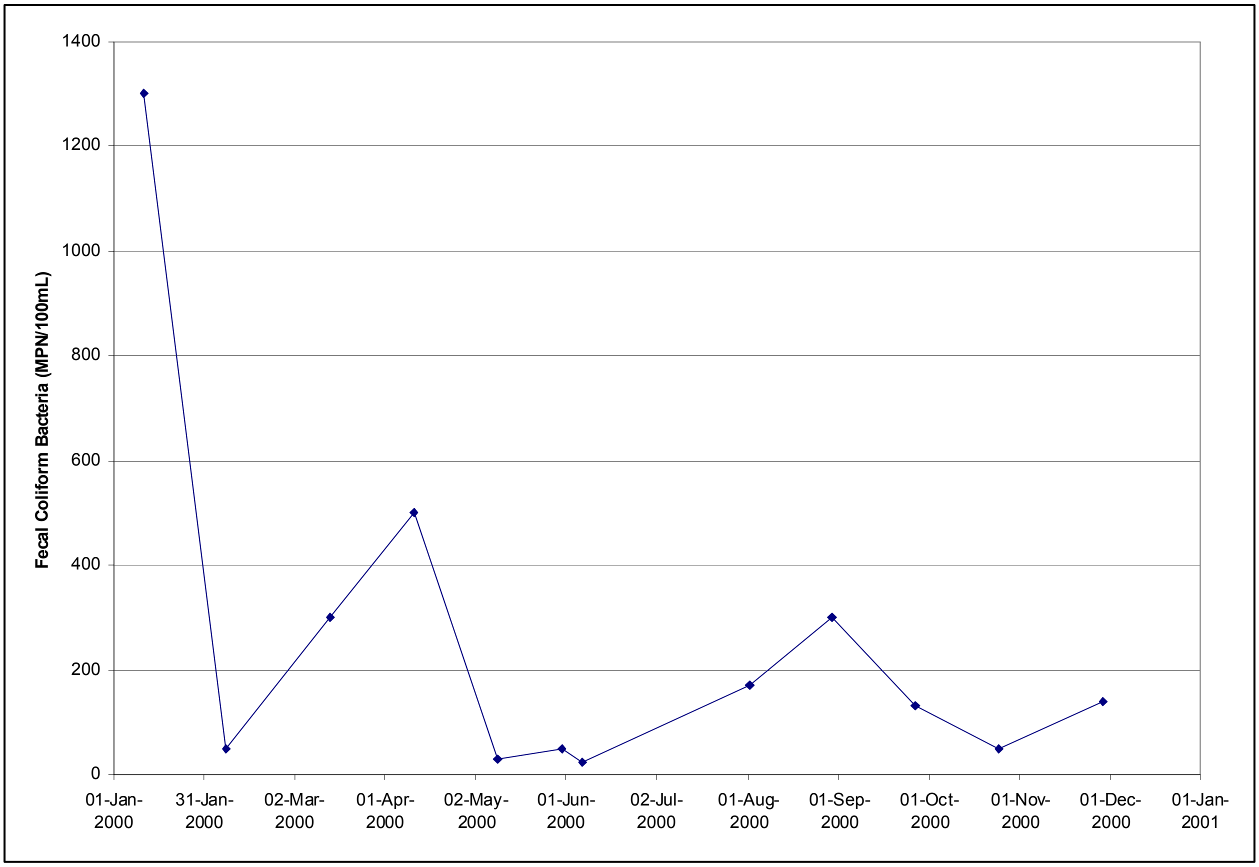

Figure C-15. Fecal coliform bacteria observations at Grand Bayou (subsegment 120206), Louisiana (station 980).

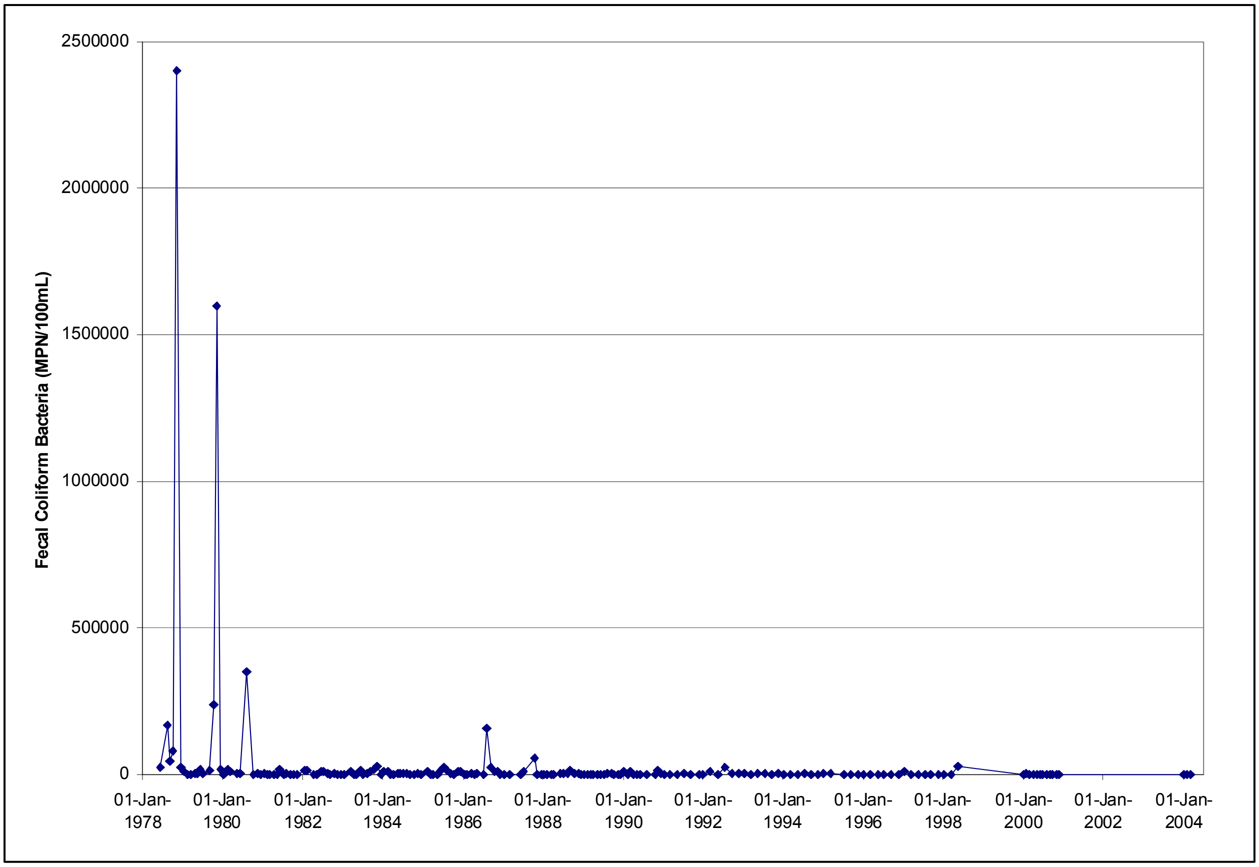

Figure C-16. Fecal coliform bacteria observations at Bayou Terrebonne (subsegment 120301) at Houma, Louisiana (station 110).

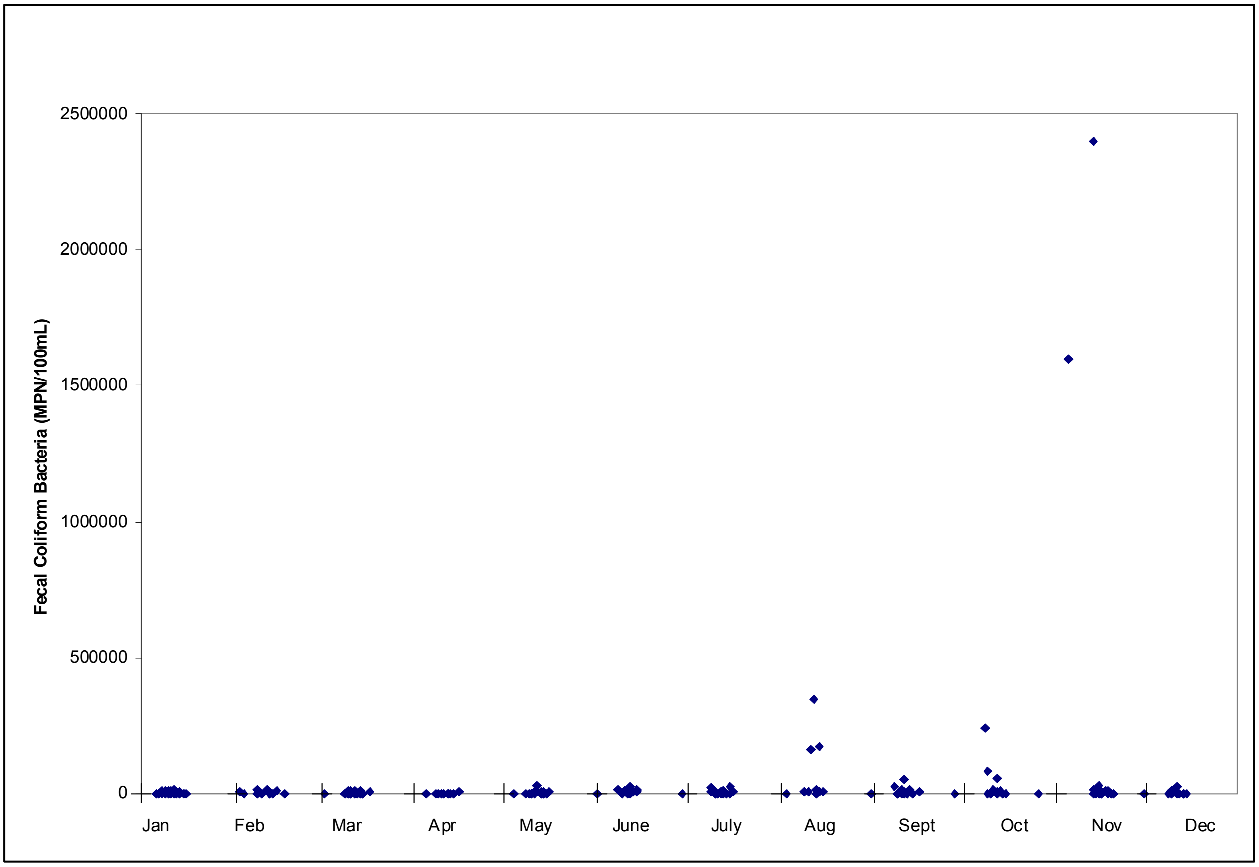

Figure C-17. Seasonal fecal coliform bacteria observations at Bayou Terrebonne (subsegment 120301) at Houma, Louisiana (station 110).

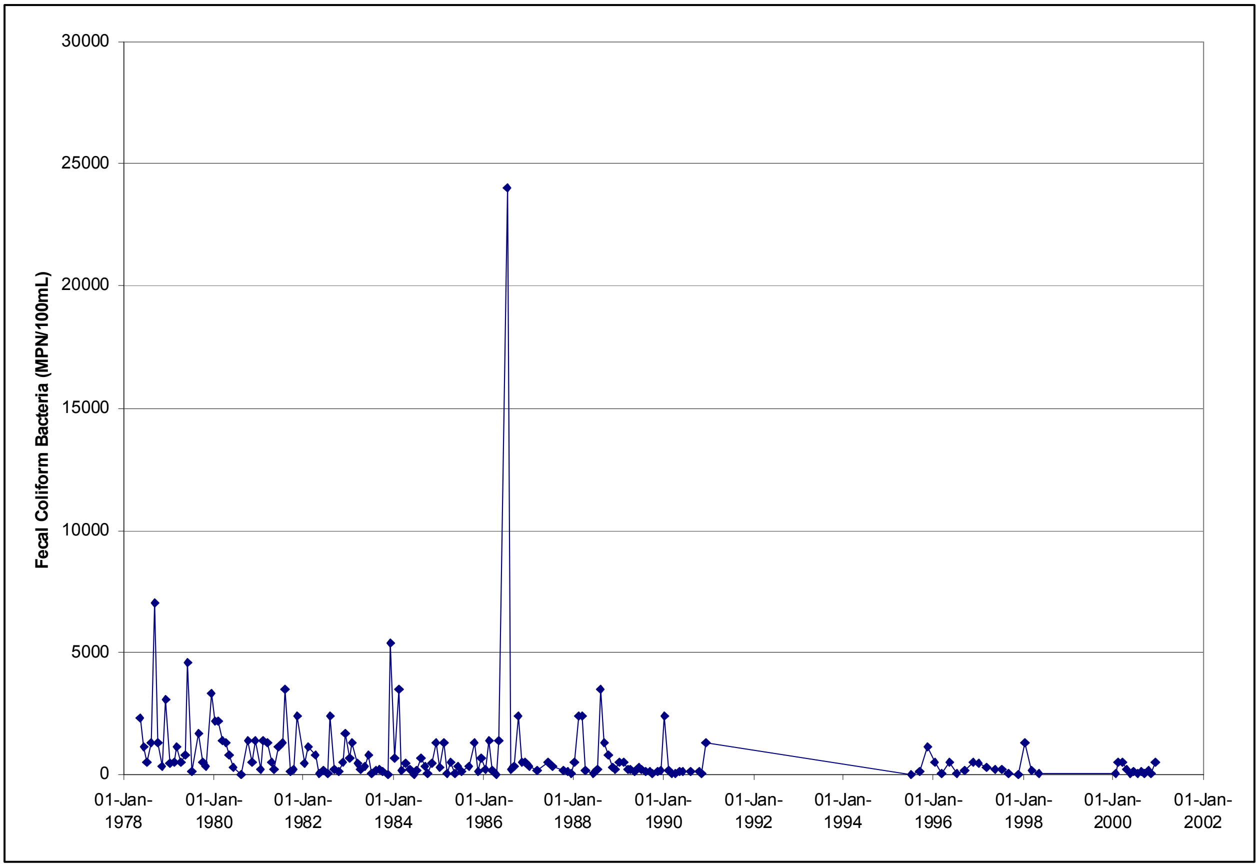

Figure C-18. Fecal coliform bacteria observations at Bayou Grand Caillou (subsegment 120502) at Dulac, Louisiana (station 113).

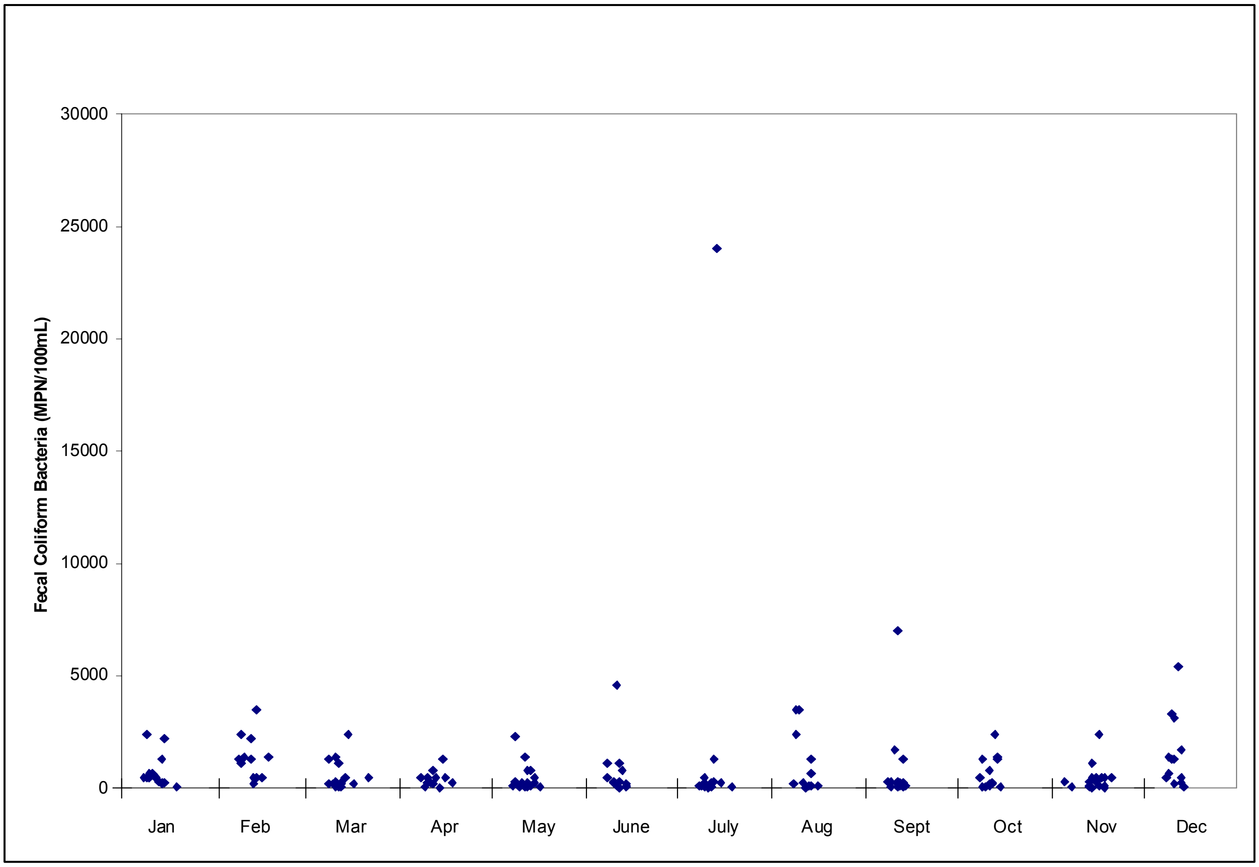

Figure C-19. Seasonal fecal coliform bacteria observations at Bayou Grand Caillou (subsegment 120502) at Dulac, Louisiana (station 113).

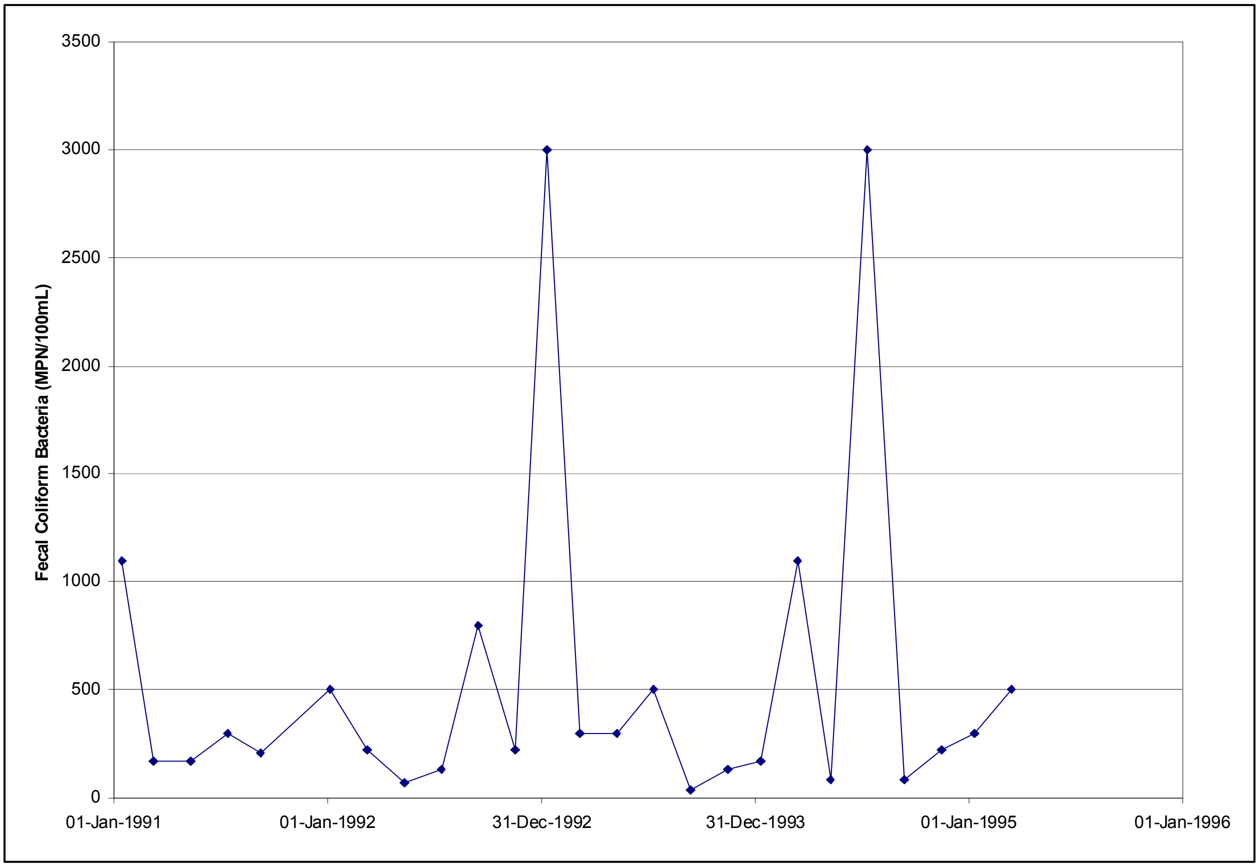

Figure C-20. Fecal coliform bacteria observations at Bayou Grand Caillou (subsegment 120502) south of Houma, Louisiana (station 348).

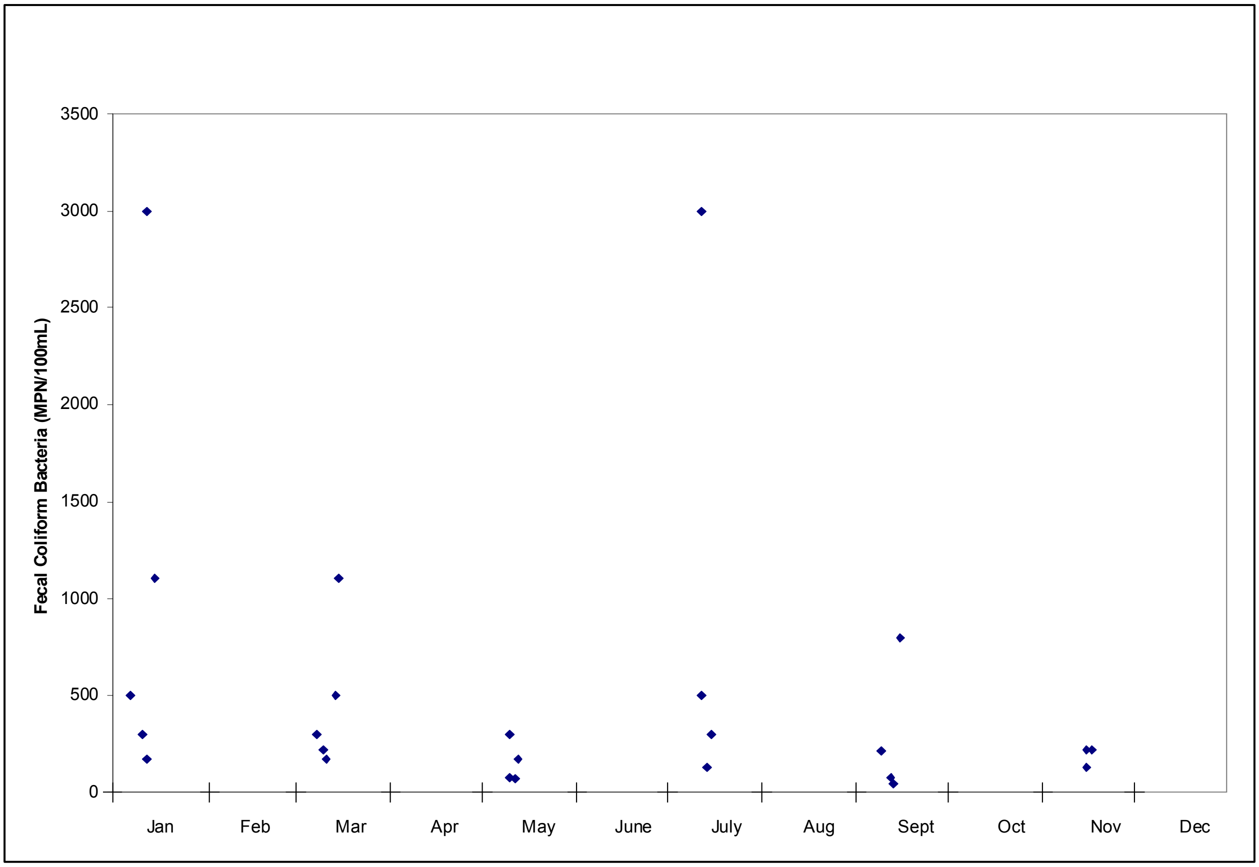

Figure C-21. Seasonal fecal coliform bacteria observations at Bayou Grand Caillou (subsegment 120502) south of Houma, Louisiana (station 348).

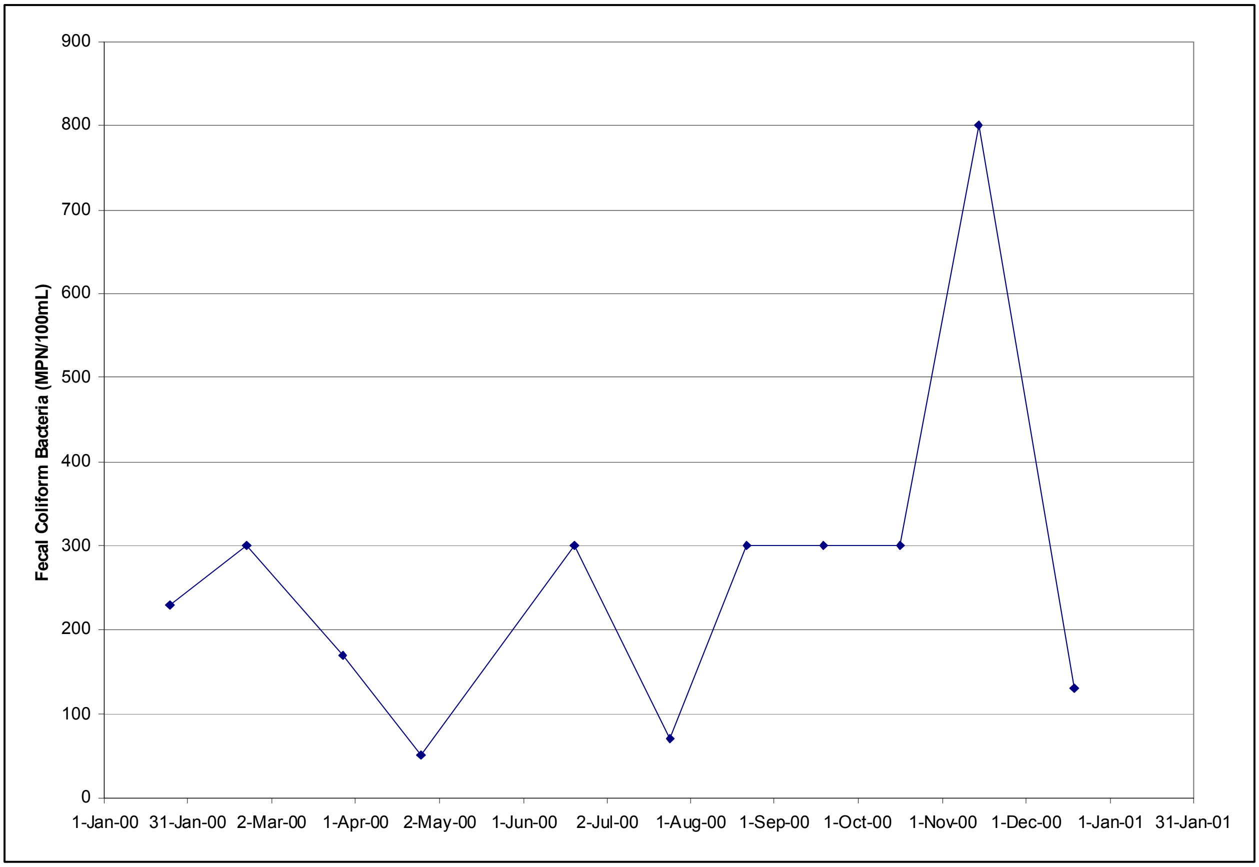

Figure C-22. Fecal coliform bacteria observations at Bayou Petit Caillou (subsegment 120503) at Klondyke Bridge, Louisiana (station 939).

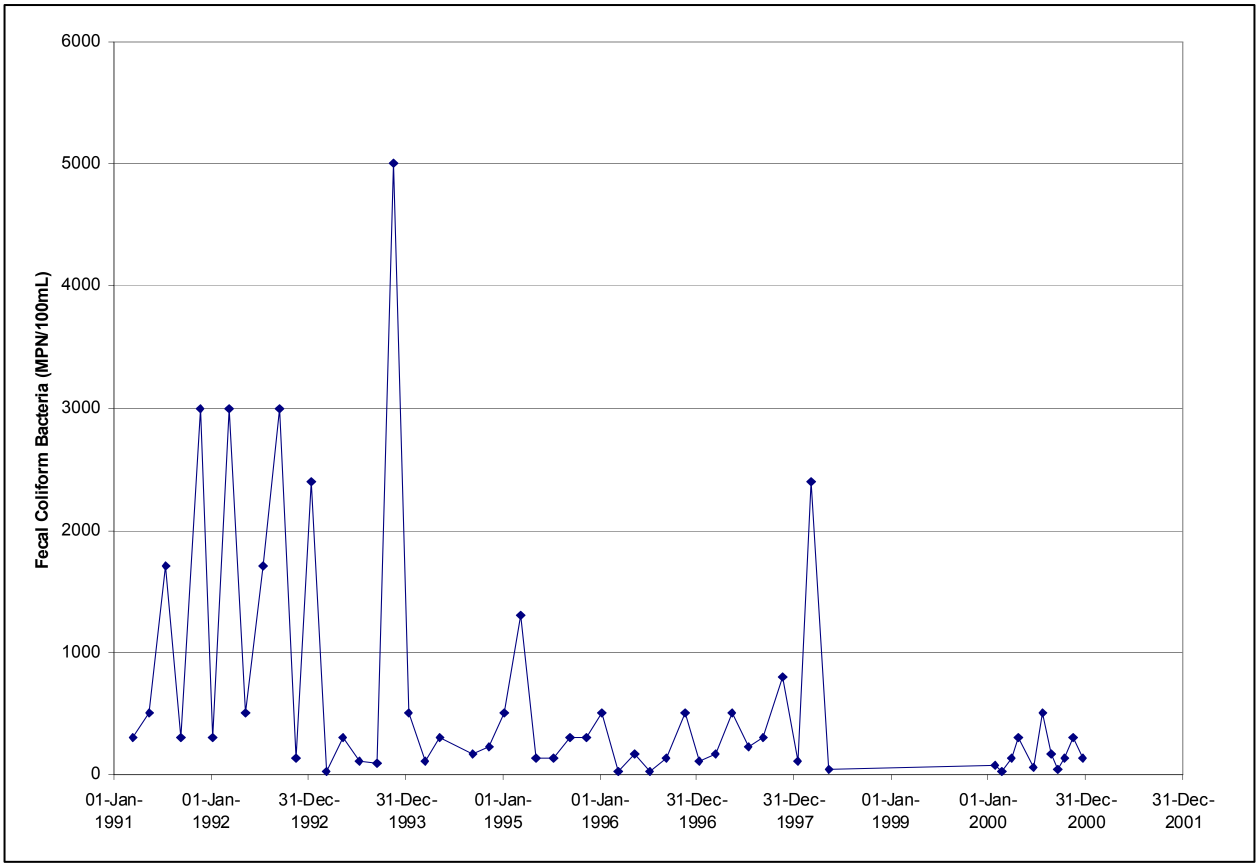

Figure C-23. Fecal coliform bacteria observations at Bayou Petit Caillou (subsegment 120504) south of Houma, Louisiana (station 347).

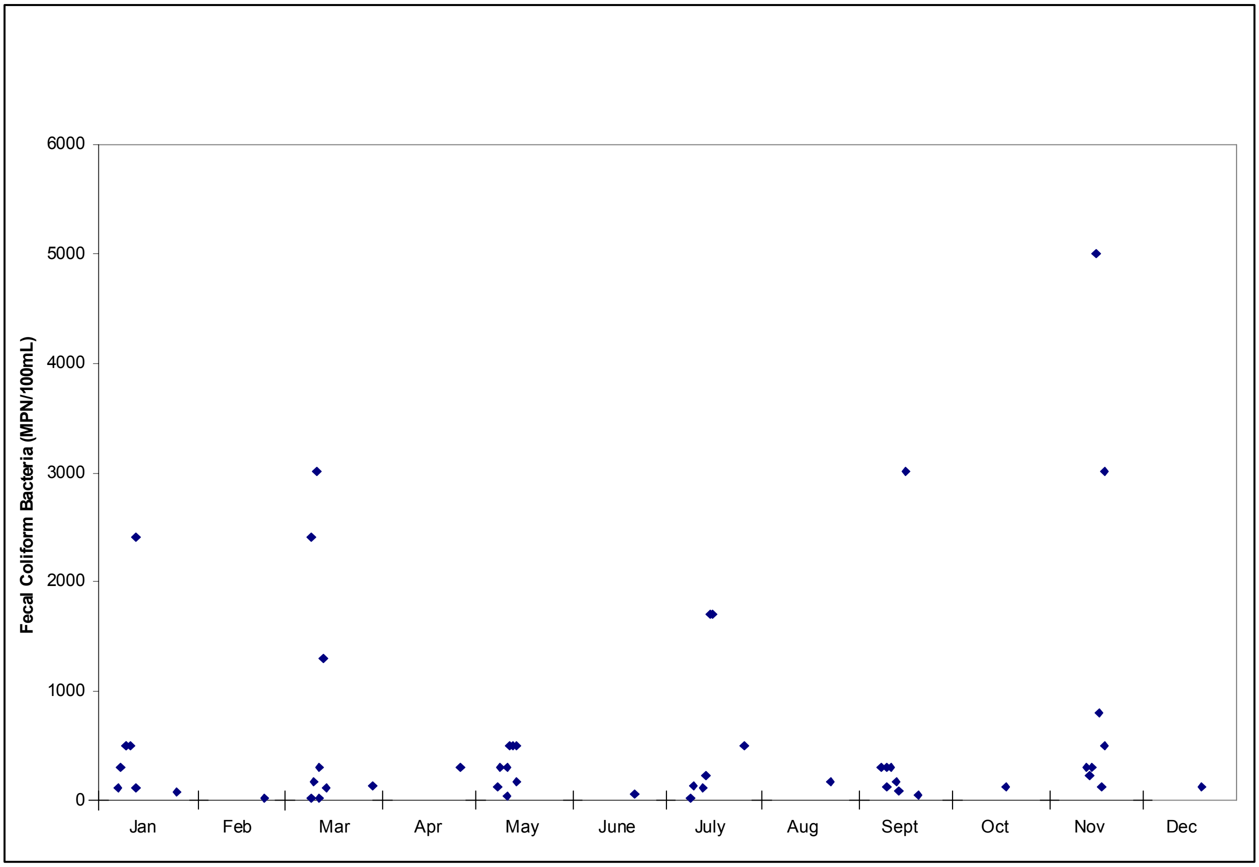

Figure C-24. Seasonal fecal coliform bacteria observations at Bayou Petit Caillou (subsegment 120504) south of Houma, Louisiana (station 347).

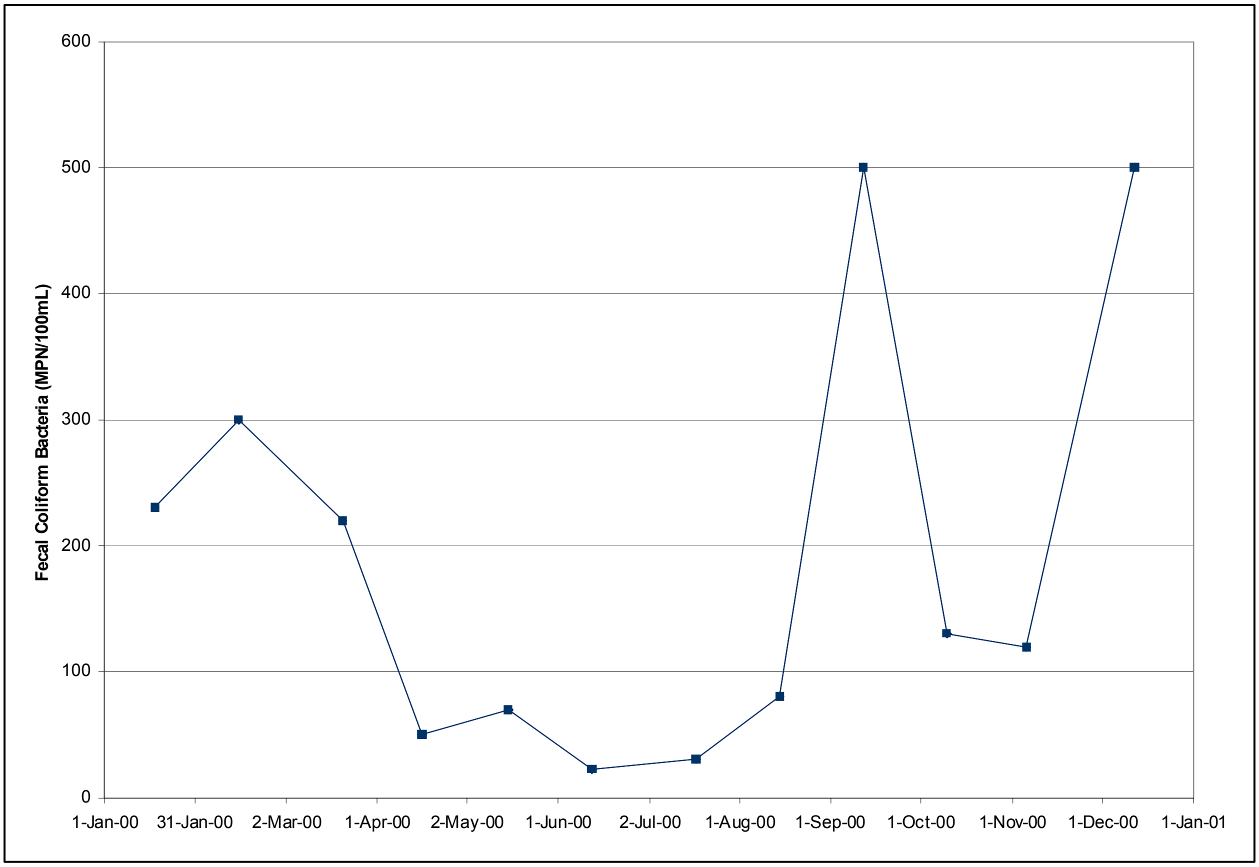

Figure C-25. Fecal coliform bacteria observations at Bayou Dularge (subsegment 120506) at Fisherman's Retreat Bridge, Louisiana (station 941).

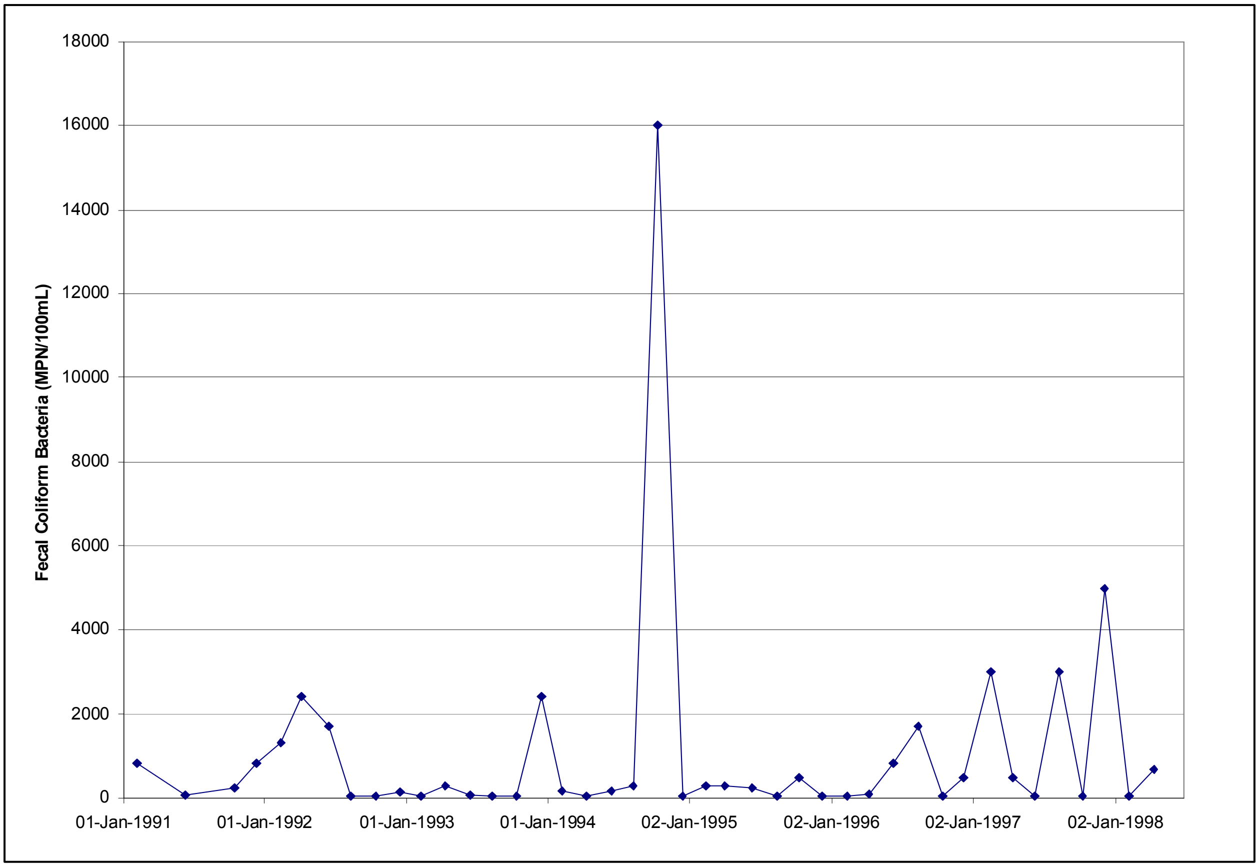

Figure C-26. Fecal coliform bacteria observations at Bayou Chauvin (subsegment 120507) near Houma, Louisiana (station 345).

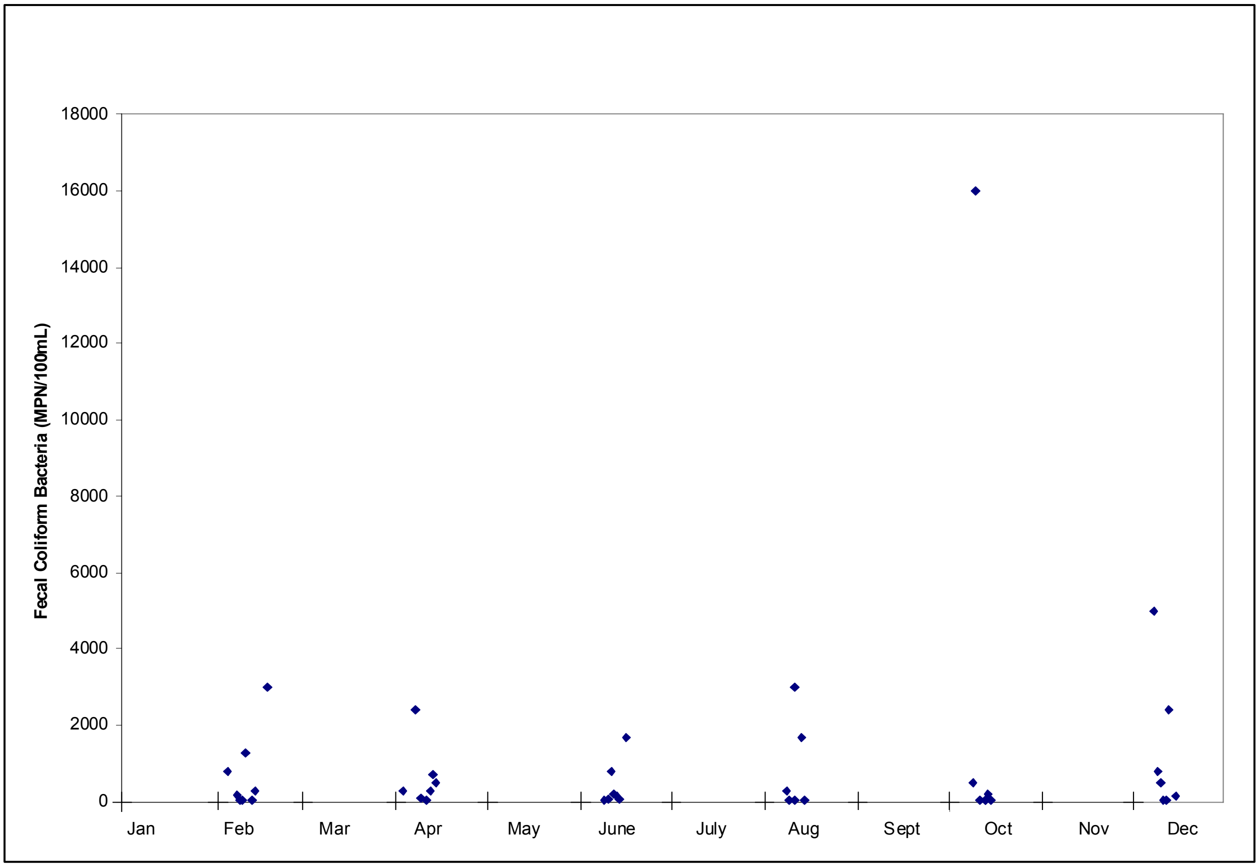

Figure C-27. Seasonal fecal coliform bacteria observations at Bayou Chauvin (subsegment 120507) near Houma, Louisiana (station 345).

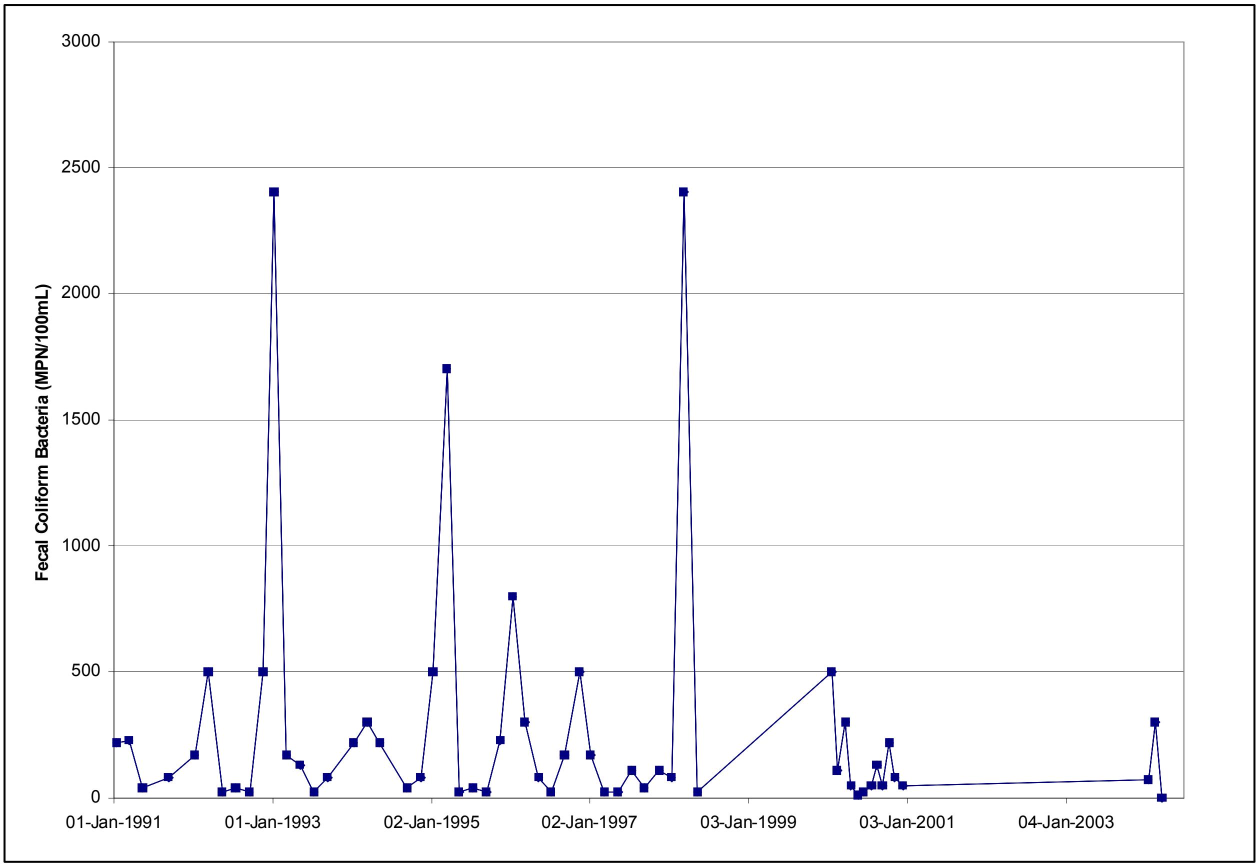

Figure C-28. Fecal coliform bacteria observations at Bayou Chauvin (subsegment 120507) south of Houma, Louisiana (station 346).

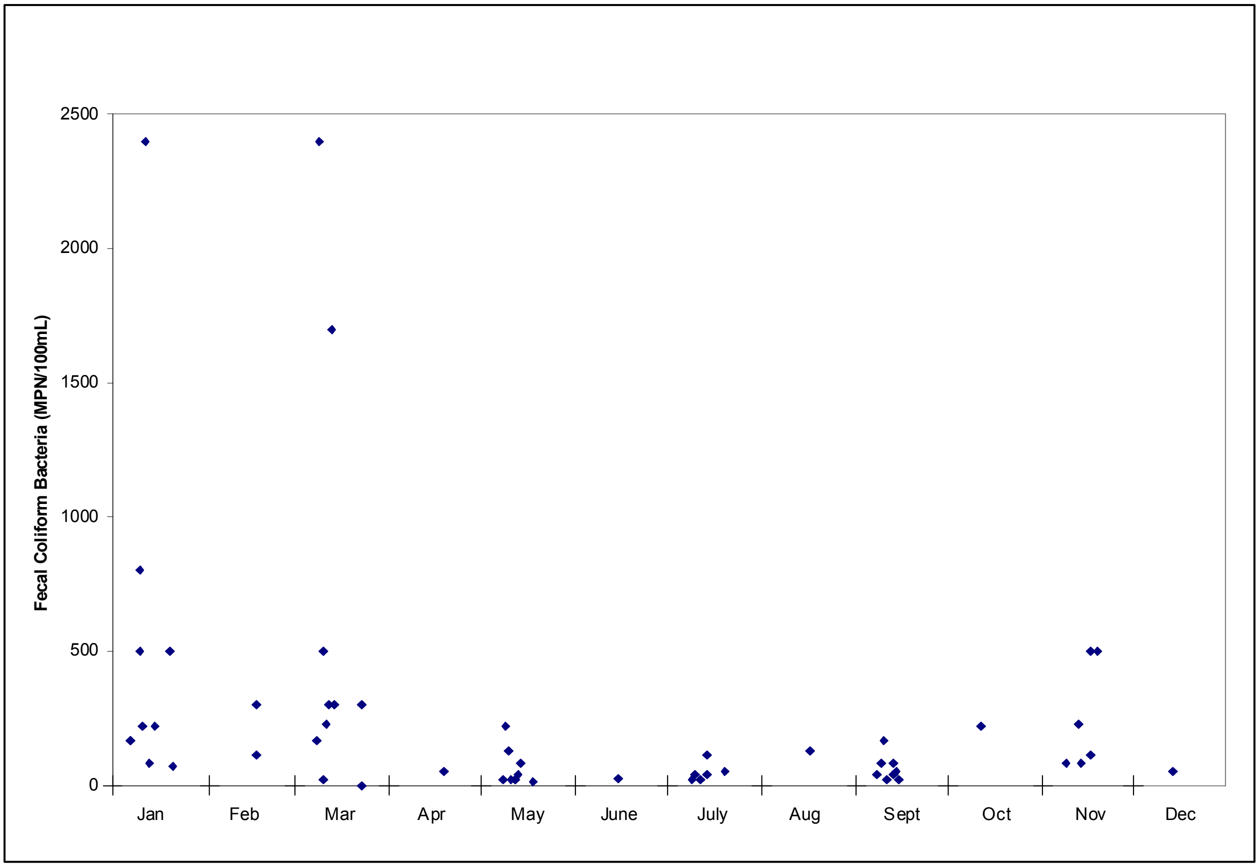

Figure C-29. Seasonal fecal coliform bacteria observations at Bayou Chauvin (subsegment 120507) south of Houma, Louisiana (station 346).

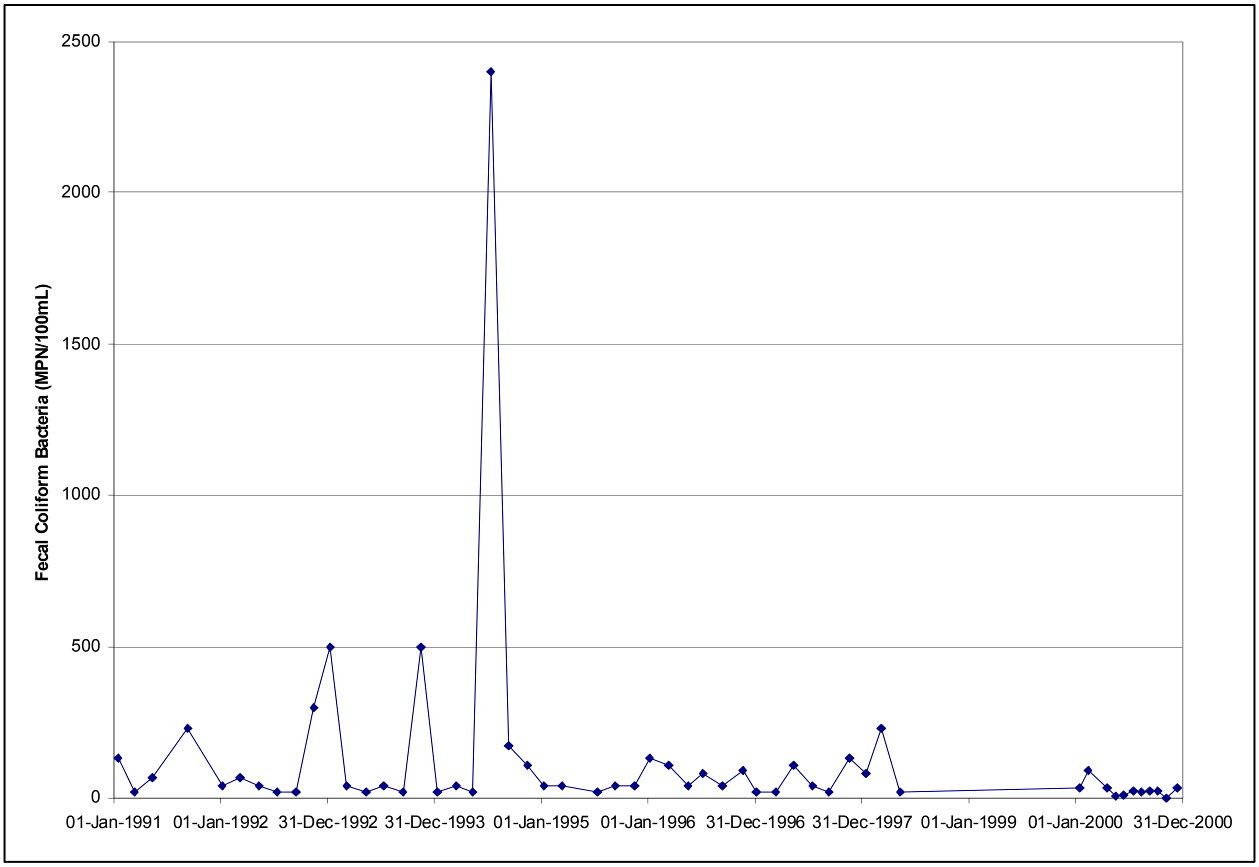

Figure C-30. Fecal coliform bacteria observations at Houma Navigation Canal (subsegment 120508) south of Houma, Louisiana (station 344).

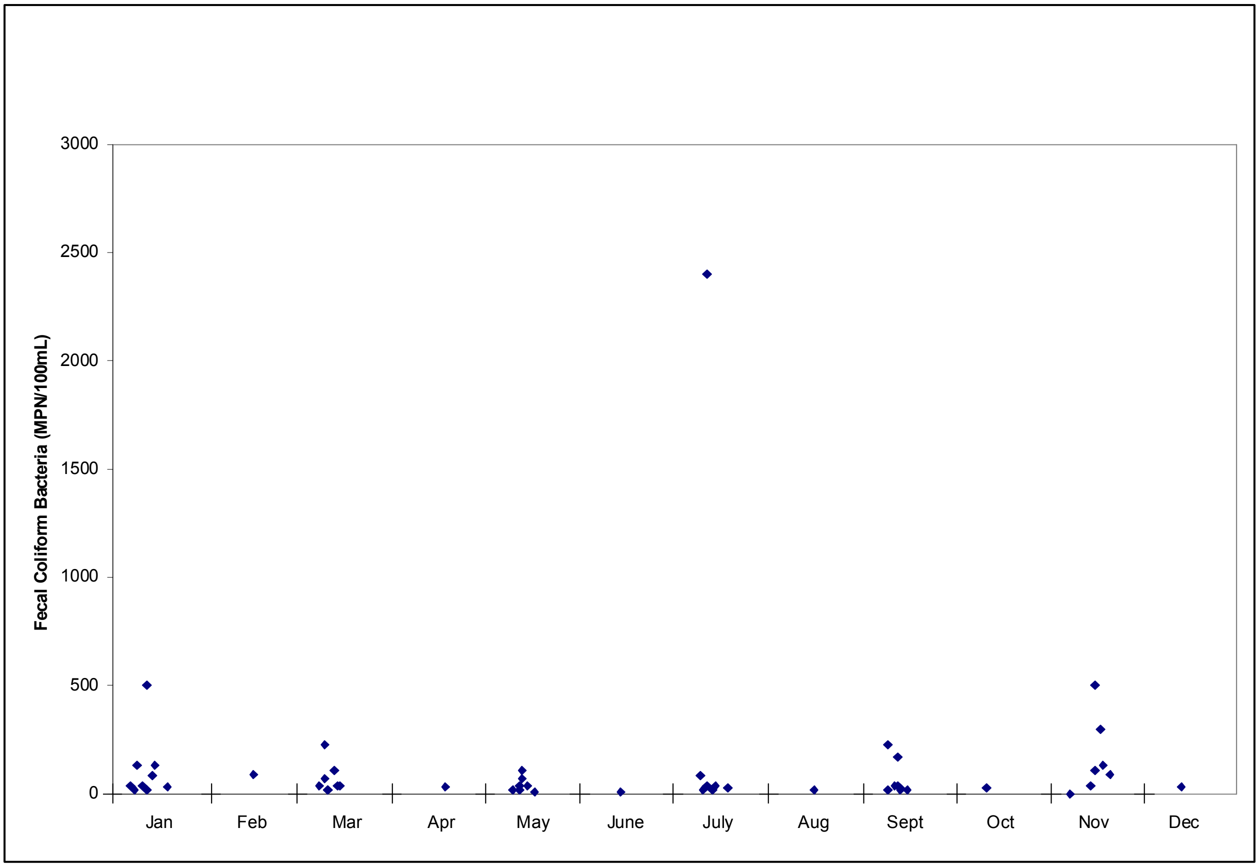

Figure C-31. Seasonal fecal coliform bacteria observations at Houma Navigation Canal (subsegment 120508) south of Houma, Louisiana (station 344).

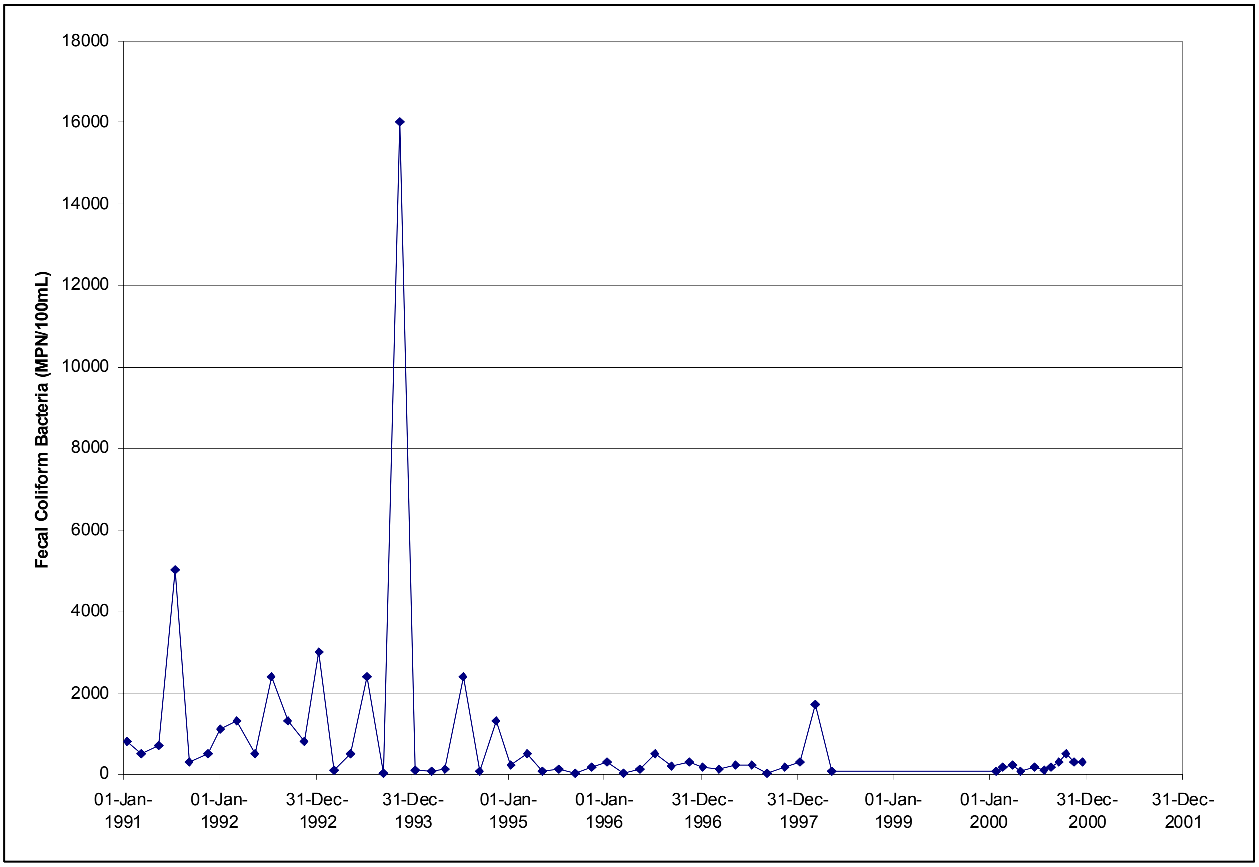

Figure C-32. Fecal coliform bacteria observations at Bayou Terrebonne (subsegment 120602) southeast of Houma, Louisiana (station 349).

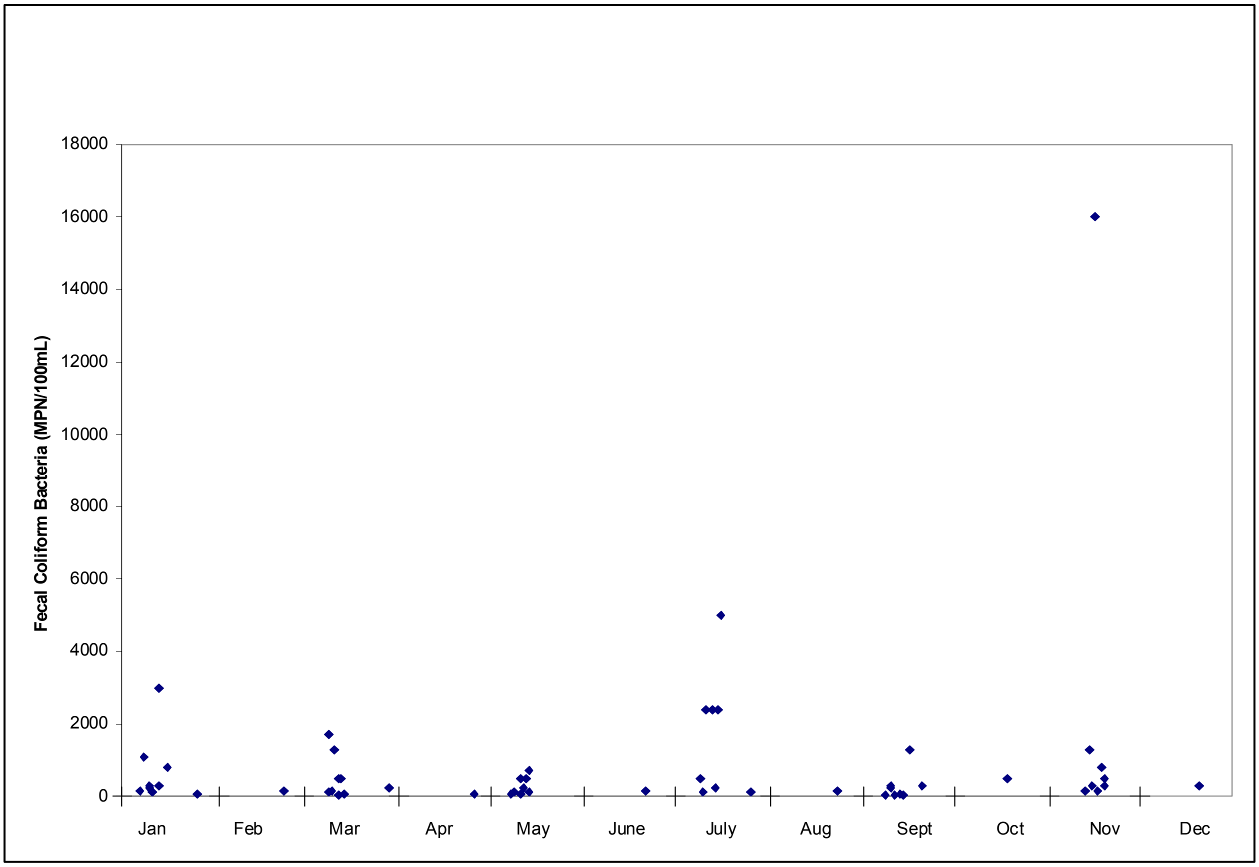

Figure C-33. Seasonal fecal coliform bacteria observations at Bayou Terrebonne (subsegment 120602) southeast of Houma, Louisiana (station 349).

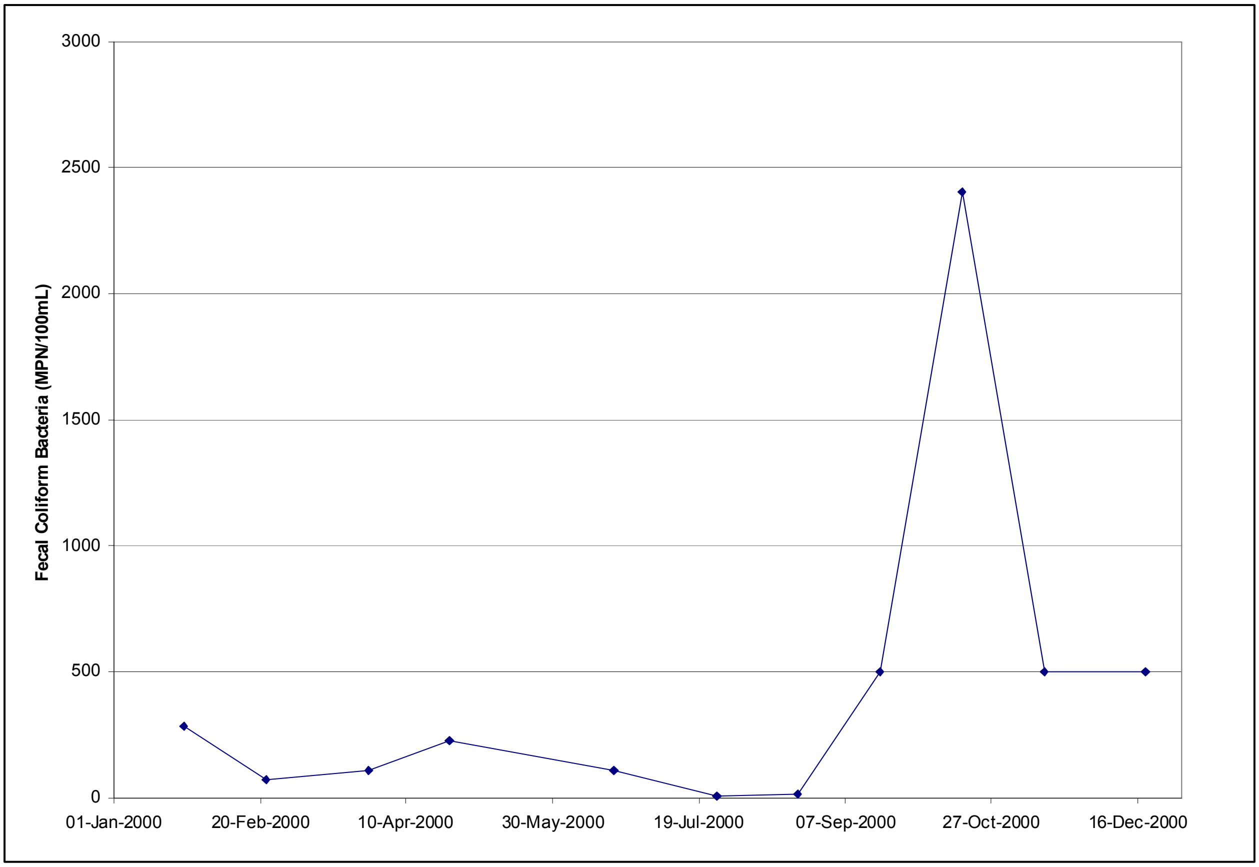

Figure C-34. Fecal coliform bacteria observations at Bayou Pointe au Chien (subsegment 120605) east of Montegut, Louisiana (station 946).

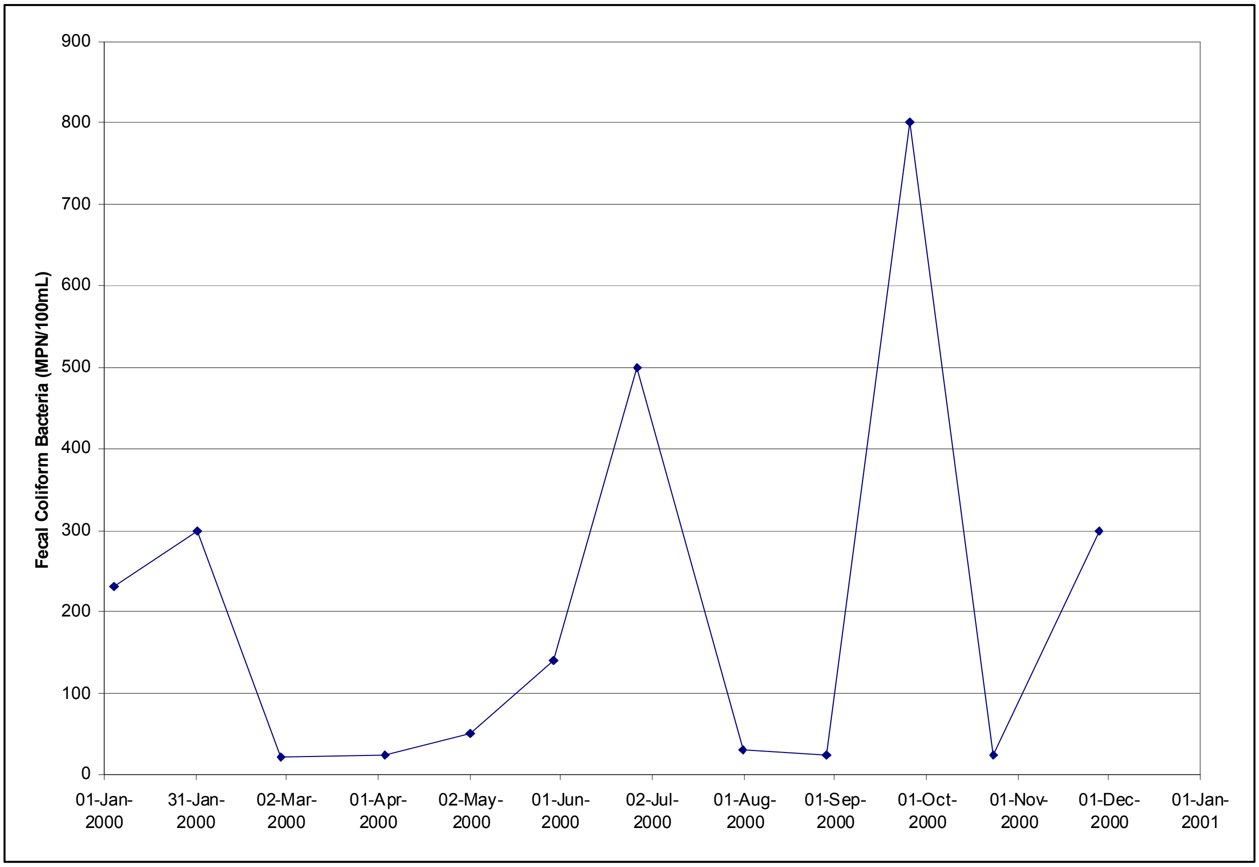

Figure C-35. Fecal coliform bacteria observations at Forty Arpent Canal (subsegment 120606) in Cutoff, Louisiana (station 947).

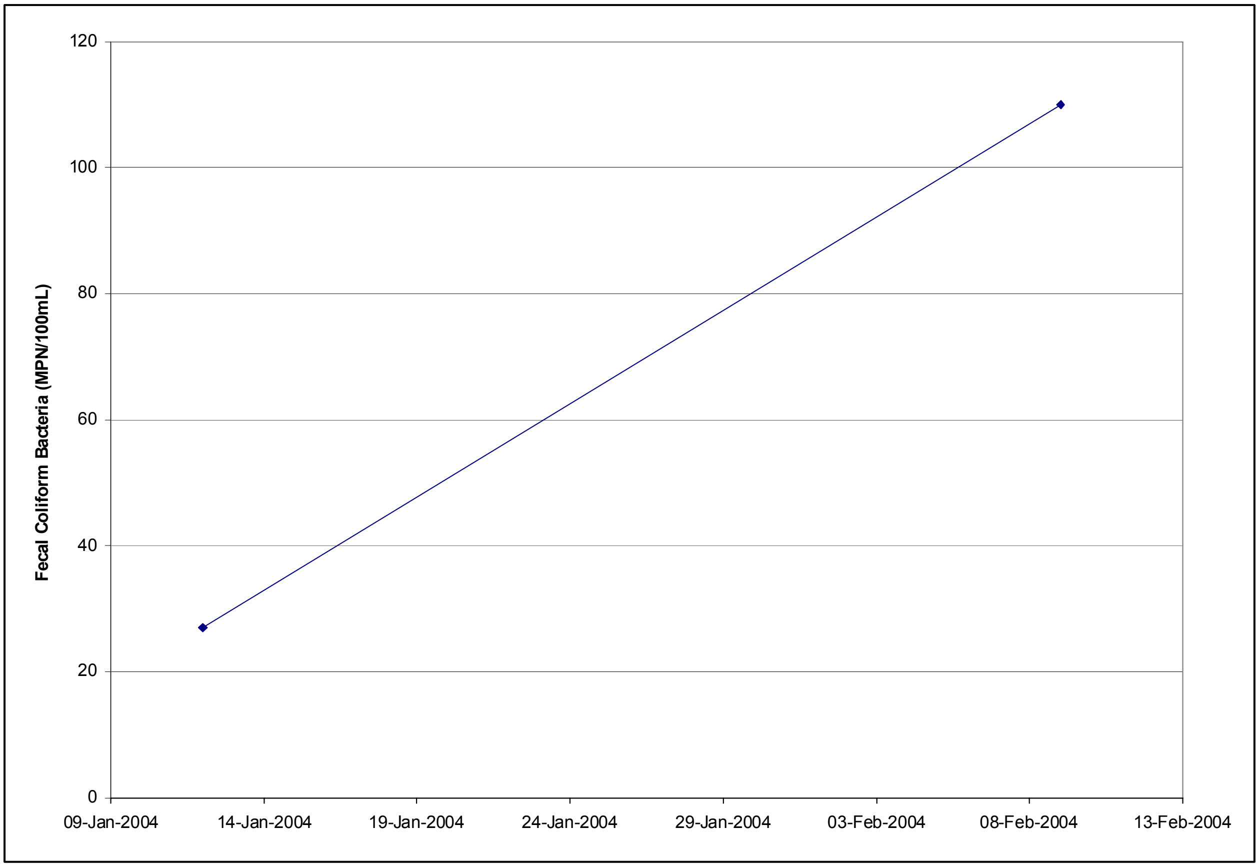

Figure C-36. Fecal coliform bacteria observations at Bayou Blue (subsegment 120606) south of Larose, Louisiana (station 2844).

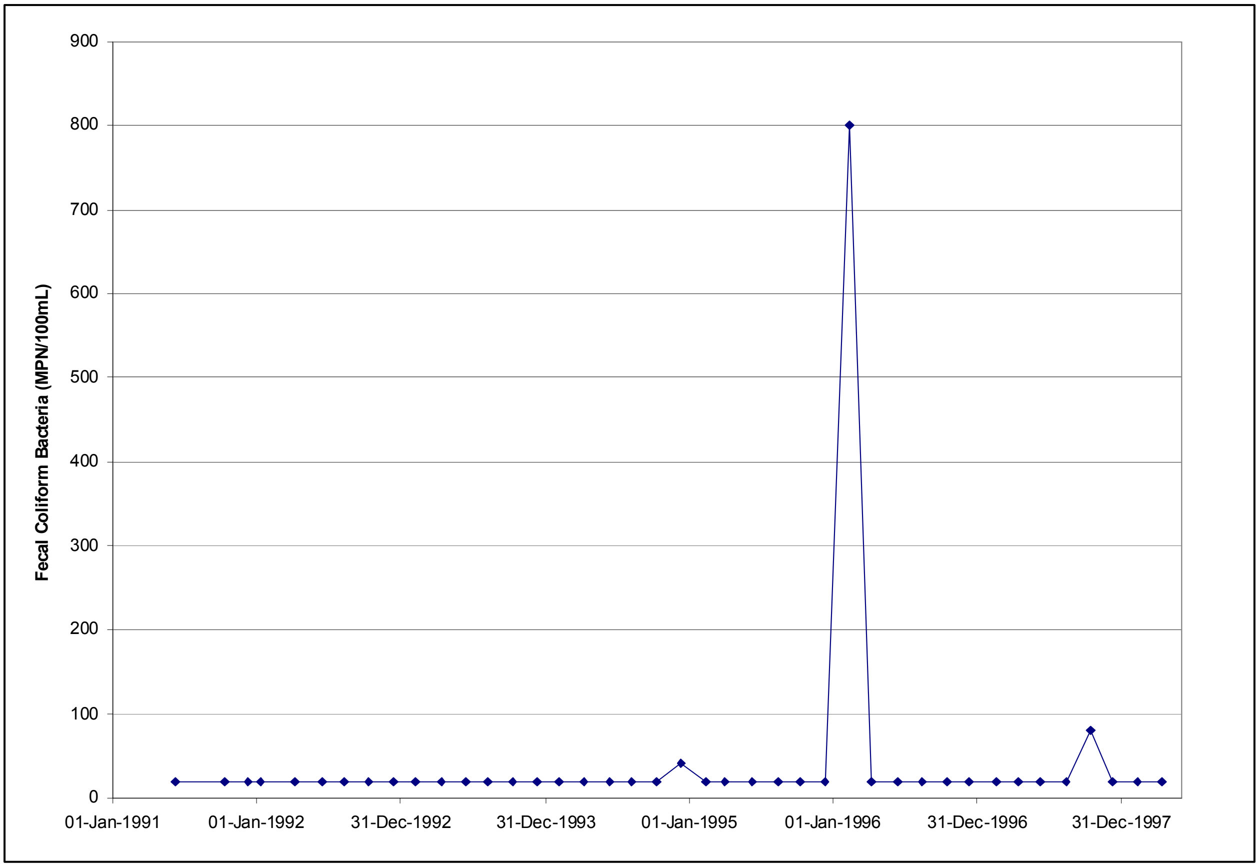

Figure C-37. Fecal coliform bacteria observations at Caillou Lake (subsegment 120701) south of Houma, Louisiana (station 351).

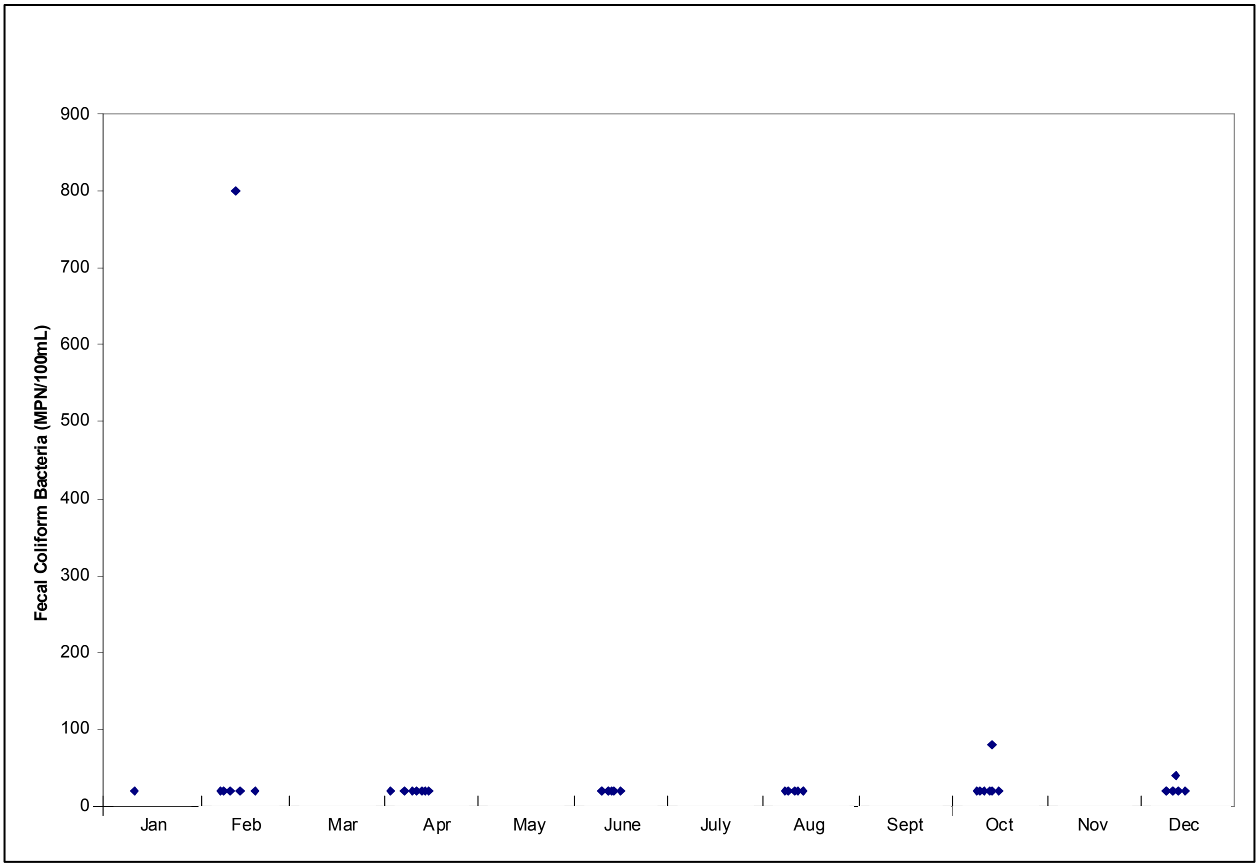

Figure C-38. Seasonal fecal coliform bacteria observations at Caillou Lake (subsegment 120701) south of Houma, Louisiana (station 351).

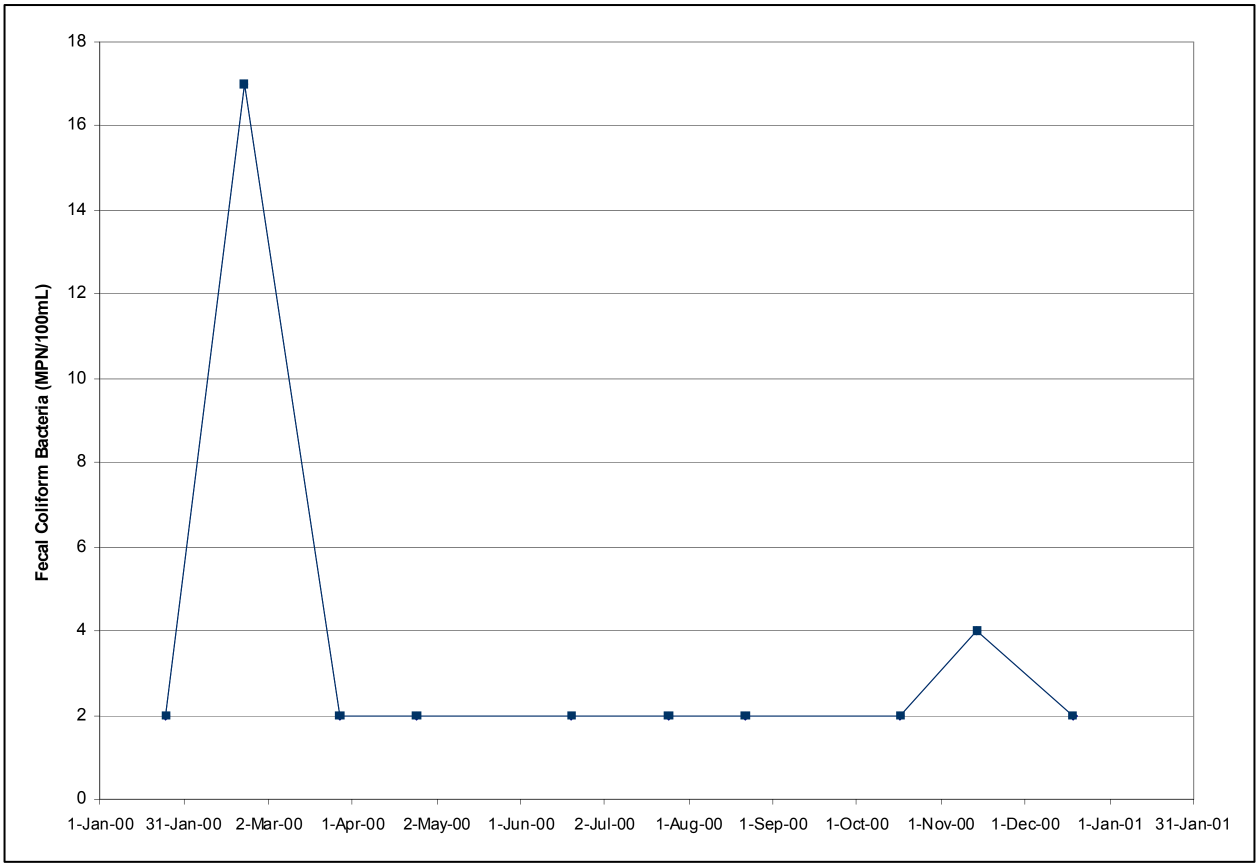

Figure C-39. Fecal coliform bacteria observations at Bayou Grand Caillou (subsegment 120701) at China Island, Louisiana (station 948).

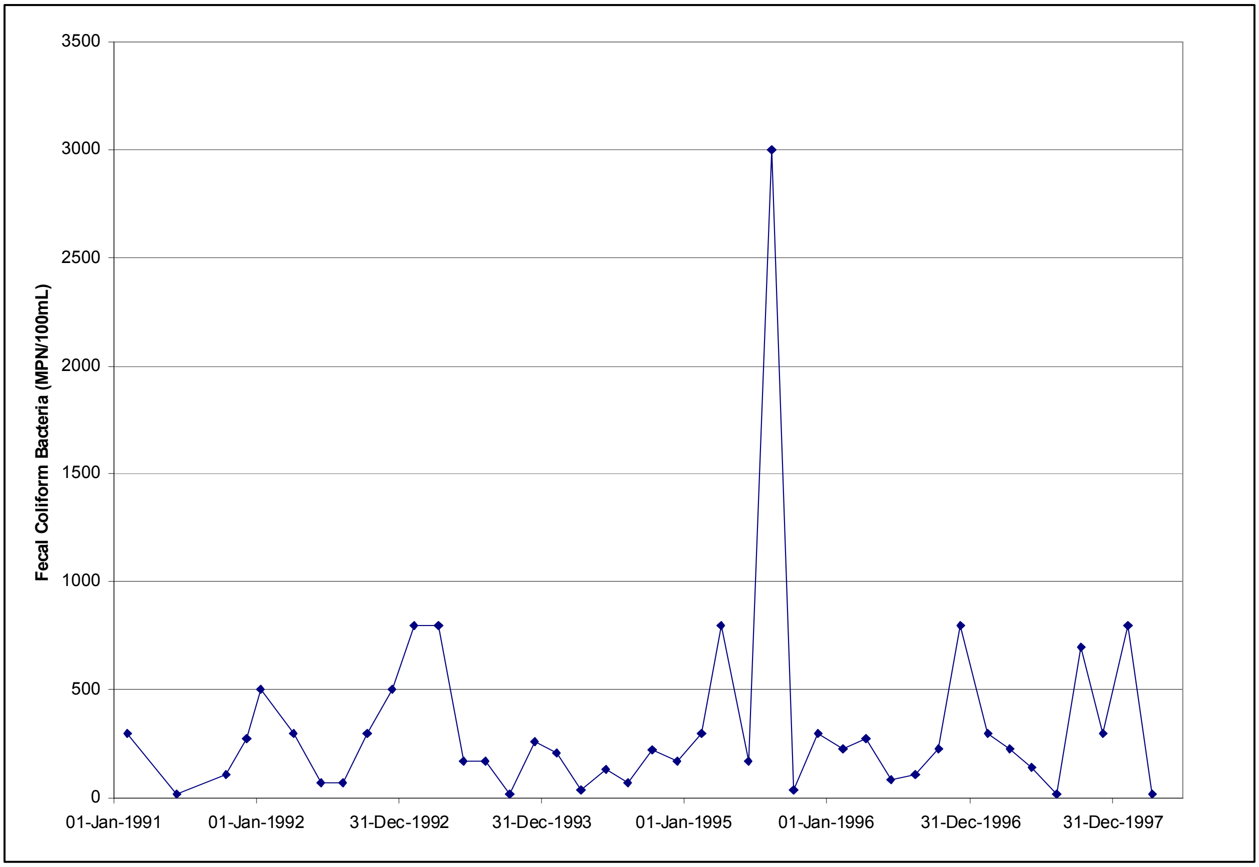

Figure C-40. Fecal coliform bacteria observations at Bayou Dularge (subsegment 120703) south of Houma, Louisiana (station 350).

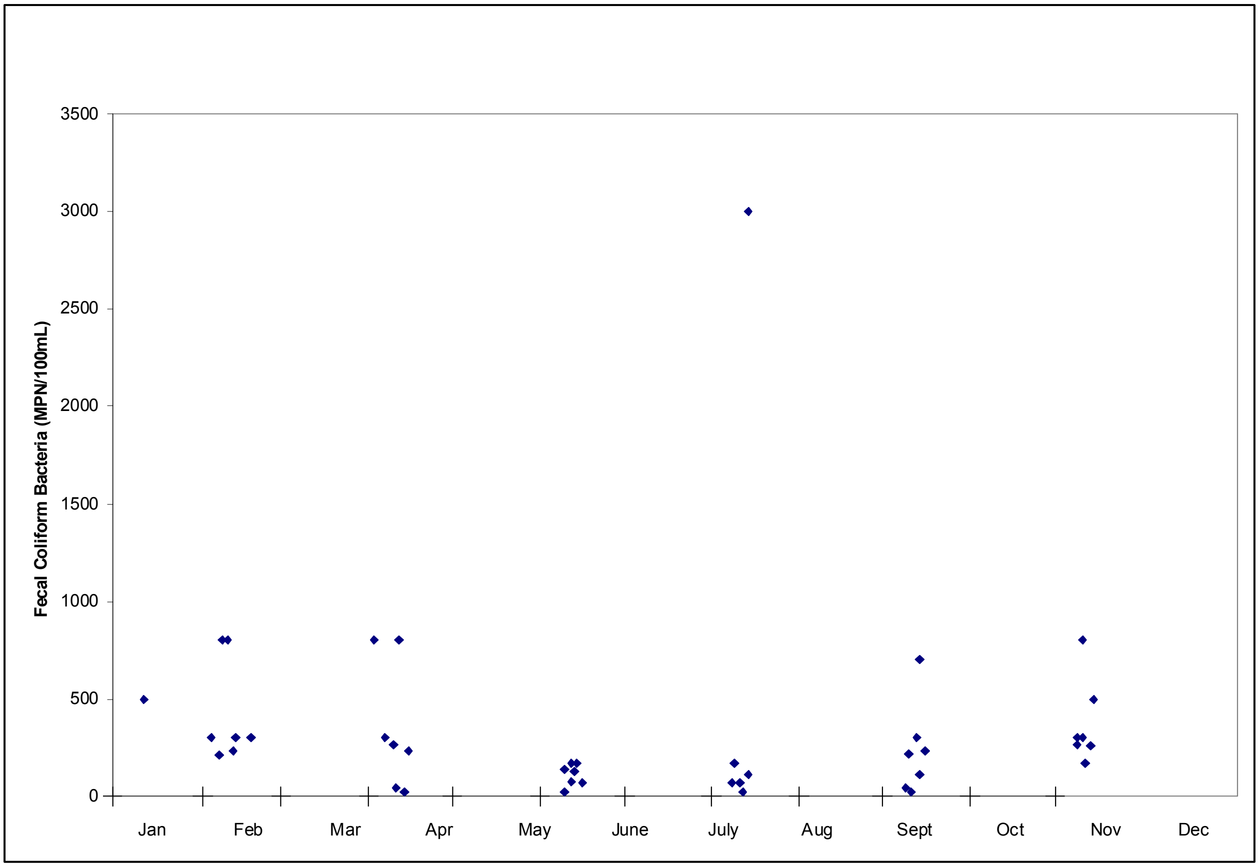

Figure C-41. Seasonal fecal coliform bacteria observations at Bayou Dularge (subsegment 120703) south of Houma, Louisiana (station 350).

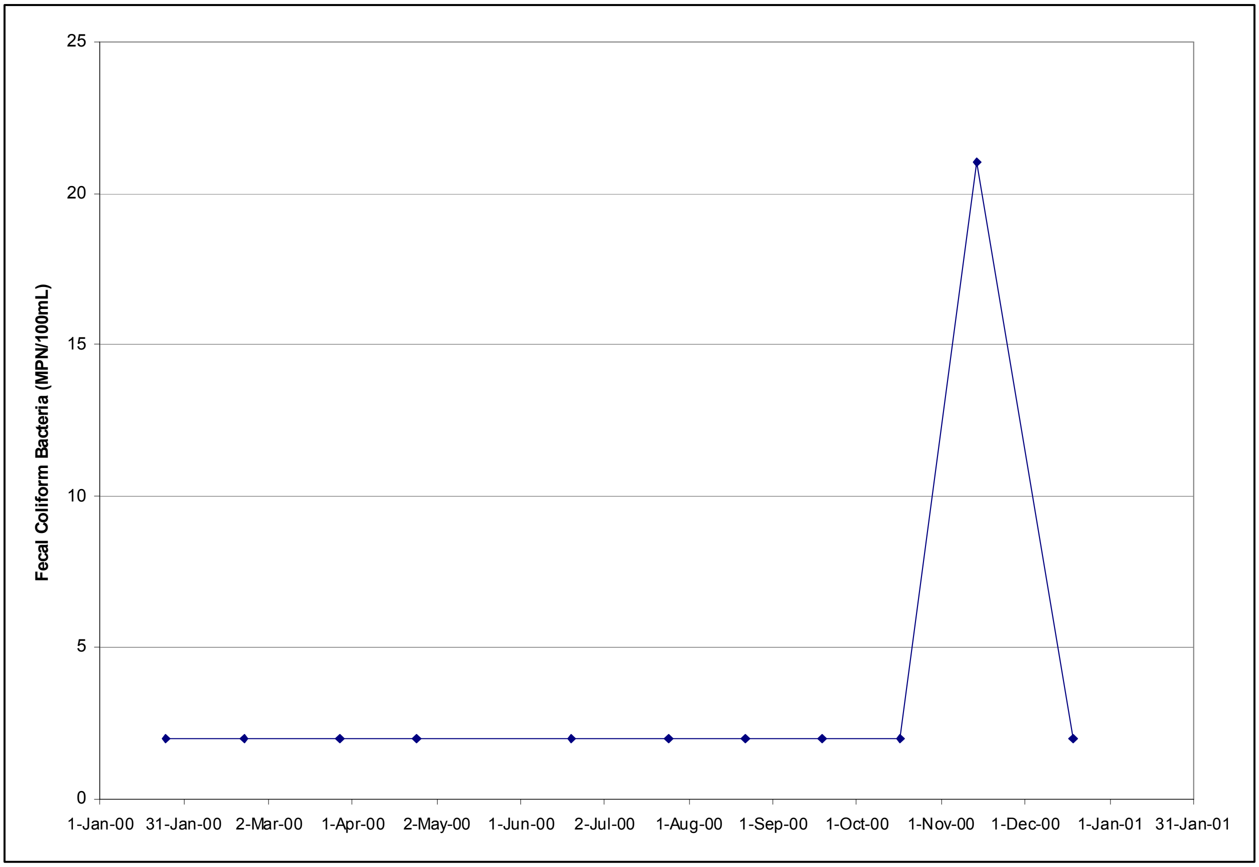

Figure C-42. Fecal coliform bacteria observations at Grand Bayou Dularge (subsegment 120703) at Bayou Voisin, Louisiana (station 950).

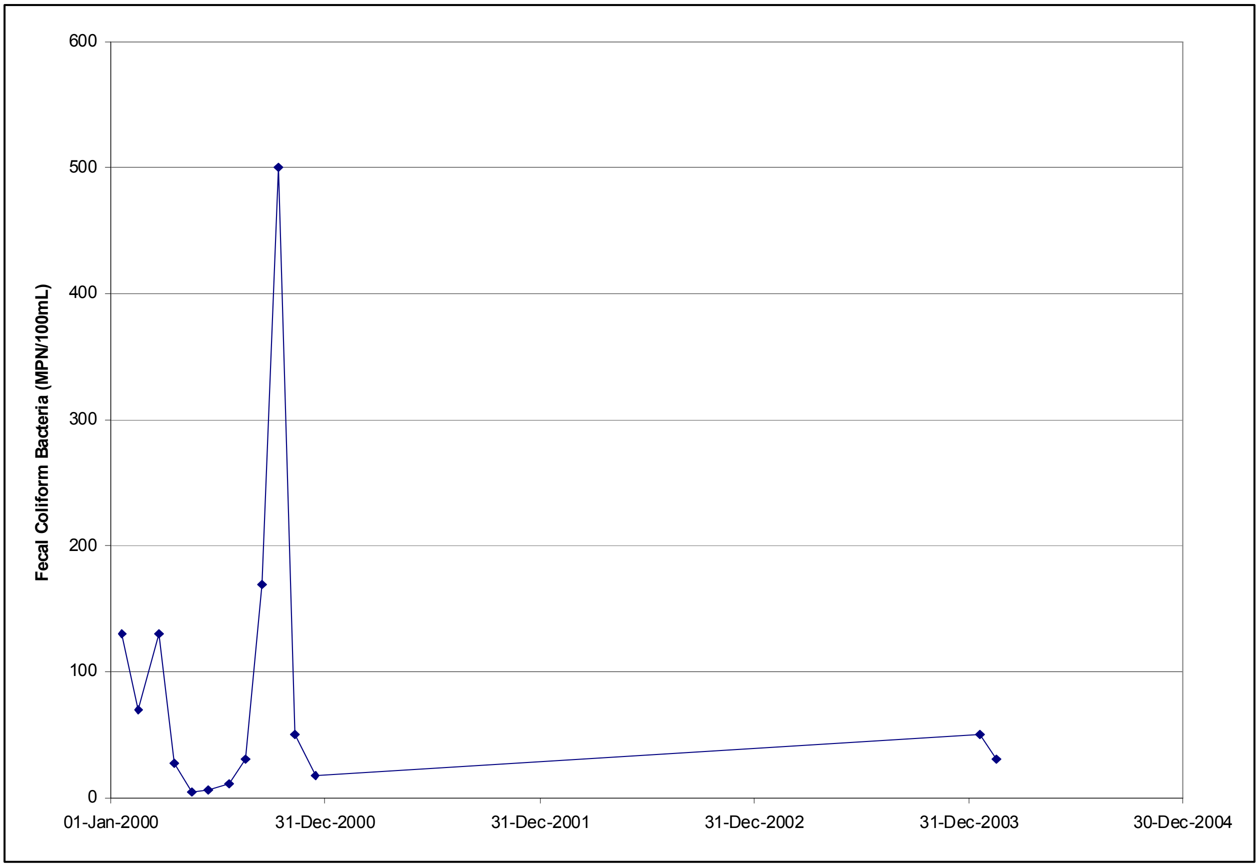

Figure C-43. Fecal coliform bacteria observations at Lake Boudreaux (subsegment 120707) south of Bayou Chauvin, Louisiana (station 954).

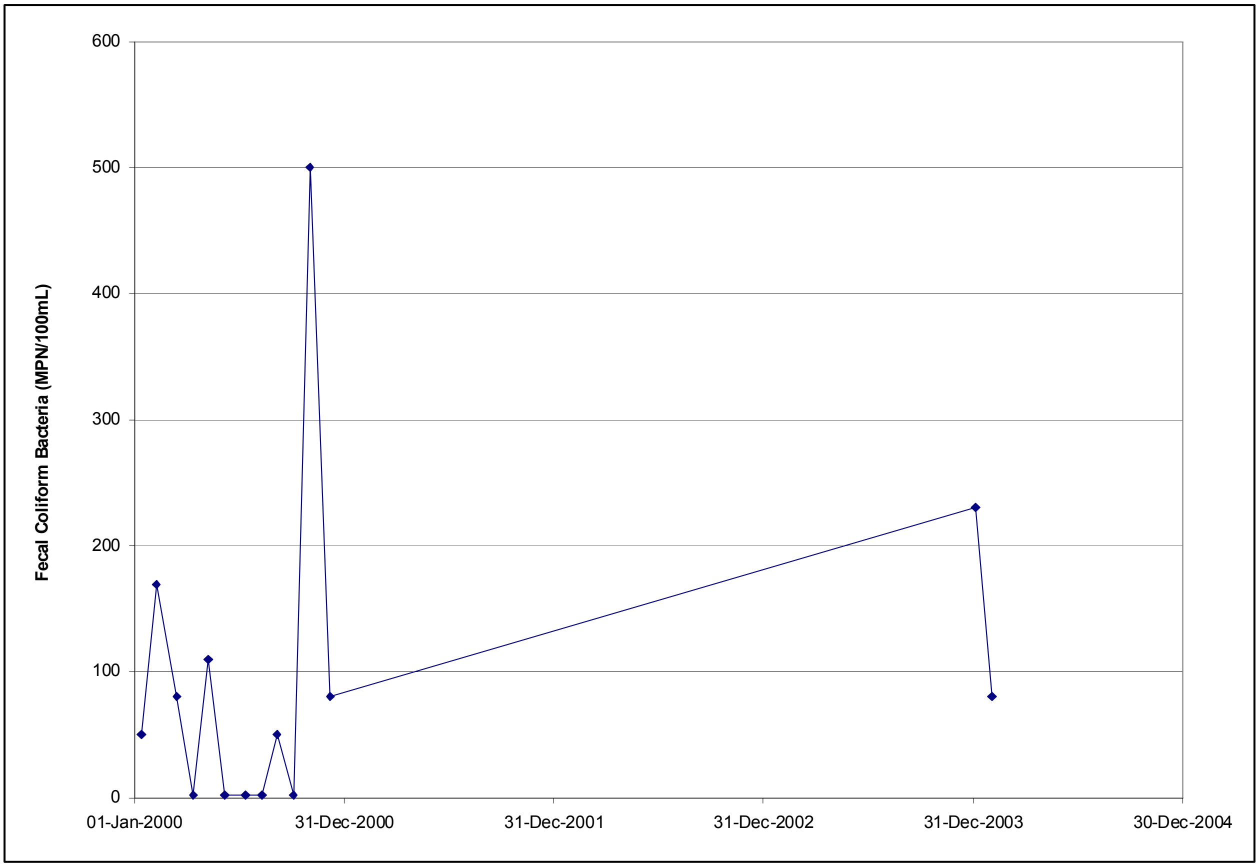

Figure C-44. Fecal coliform bacteria observations at Lost Lake (subsegment 120708) west of Bayou De Cade, Louisiana (station 955).

Appendix D
Chloride Figures for Terrebonne River Basin

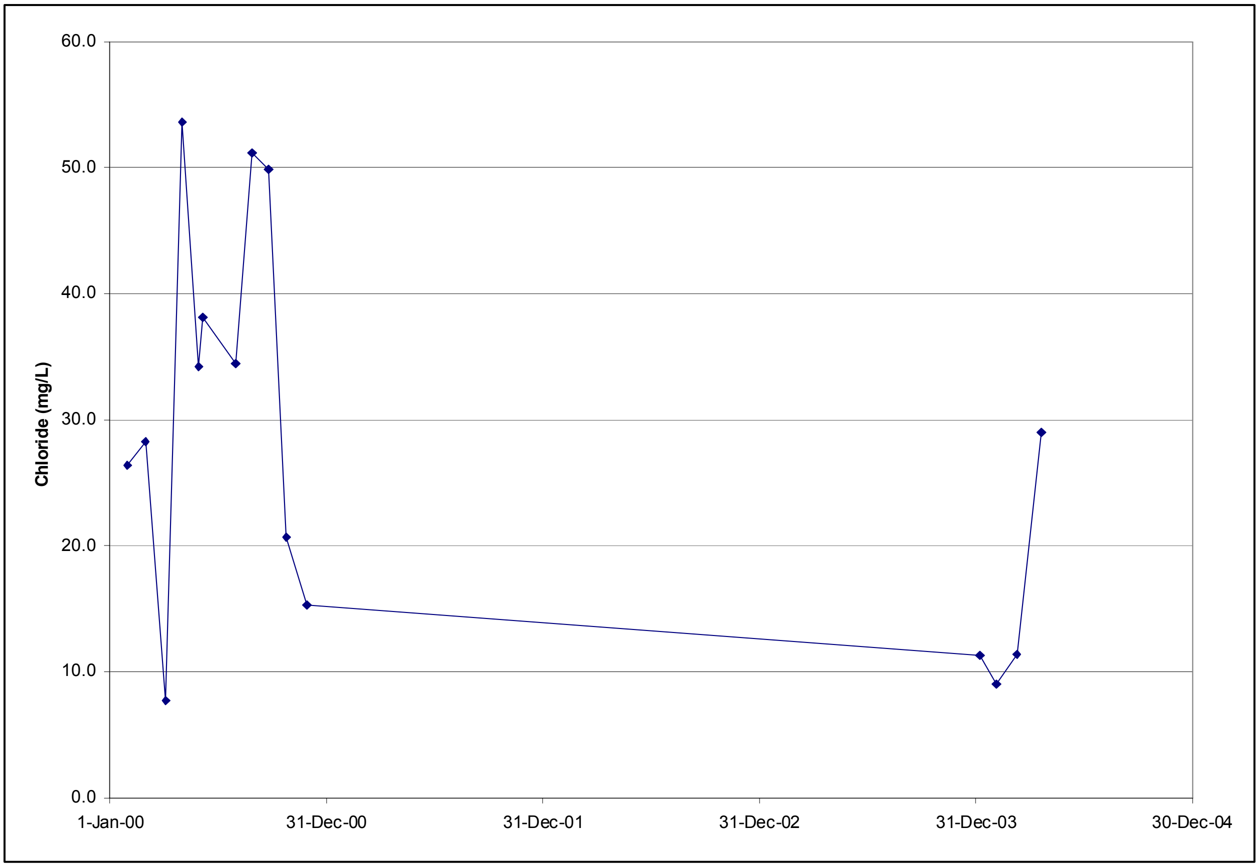

Figure D-1. Chloride observations at Bayou Portage (subsegment 120101), Louisiana (station 968).

Appendix E
Sulfate Figures for the Terrebonne River Basin

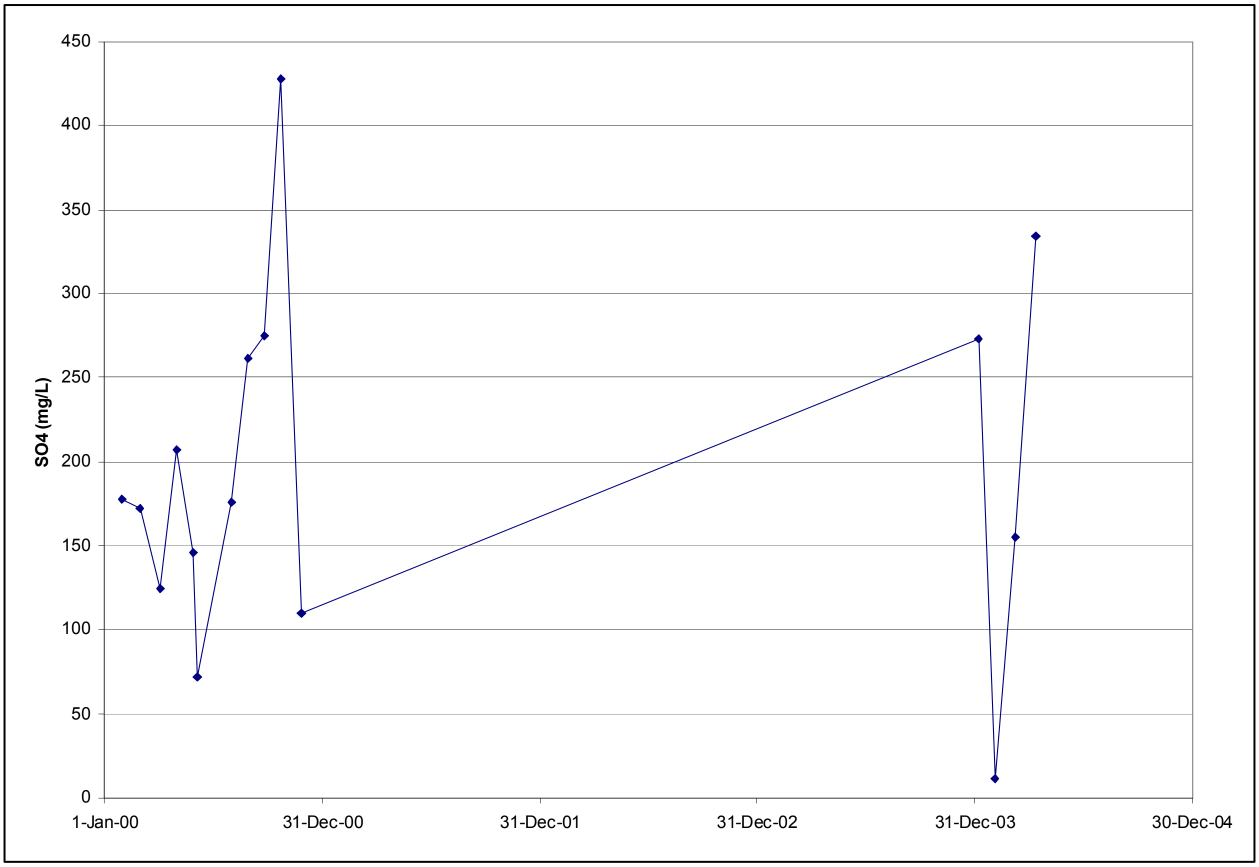

Figure E-1. Sulfate observations at Bayou Poydras (subsegment 120102), Louisiana (station 969).

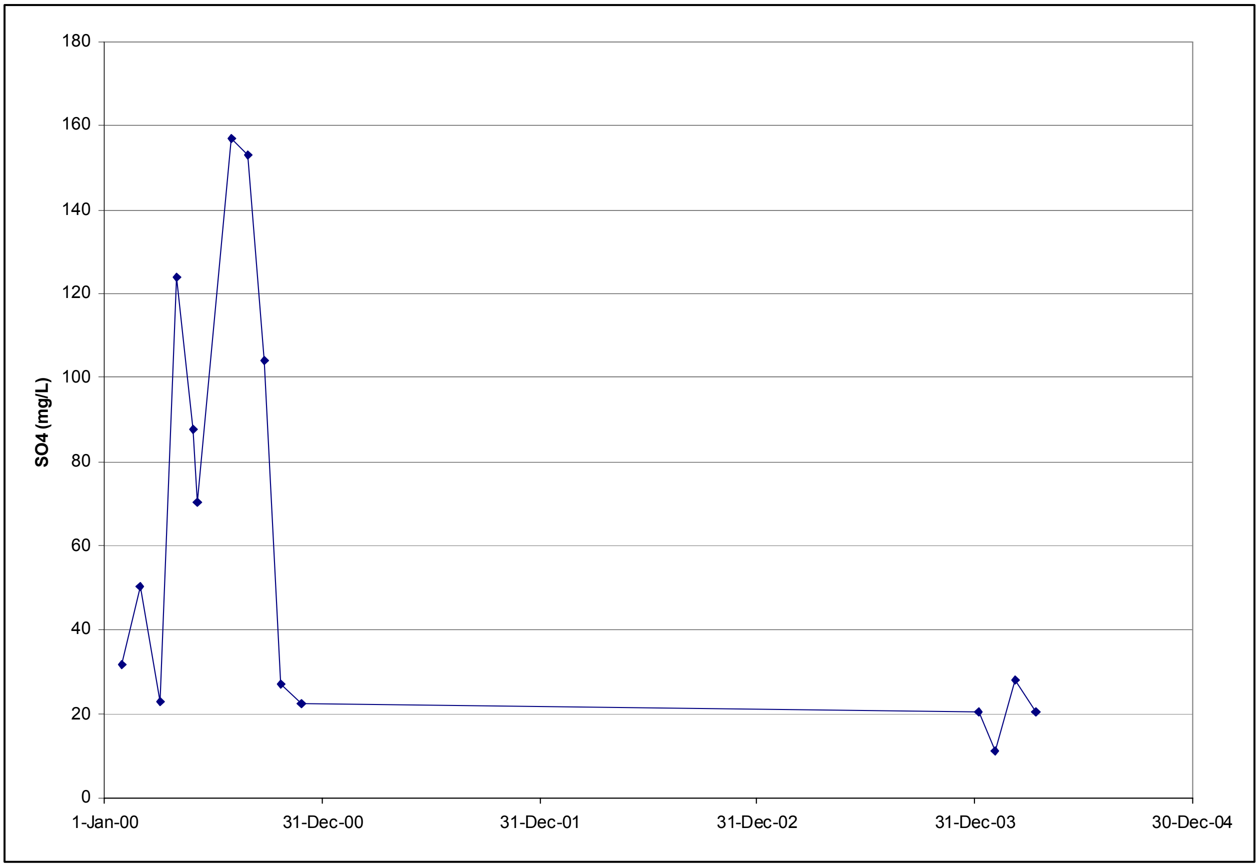

Figure E-2. Sulfate observations at Bayou Chalpin (subsegment 120110), Louisiana (station 976).

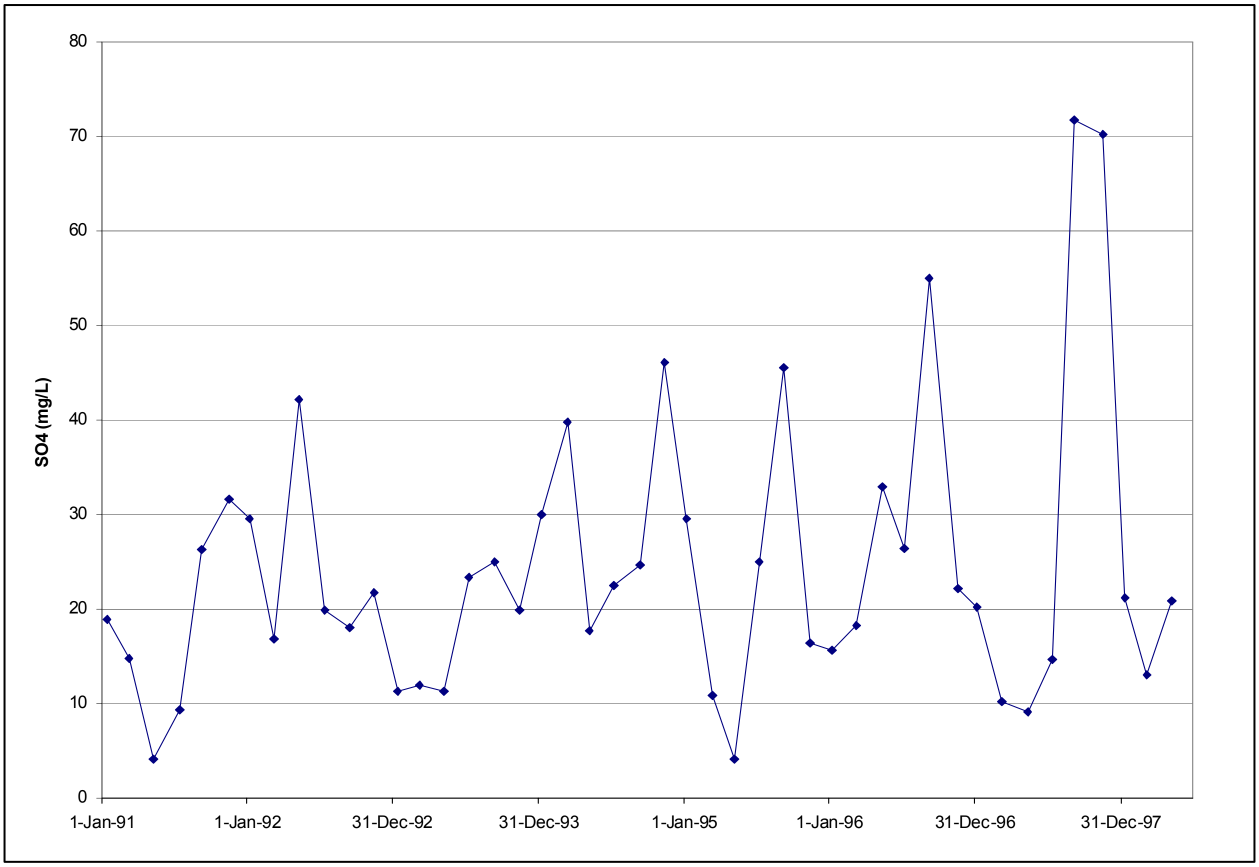

Figure E-3. Sulfate observations at Belle River (subsegment 120201) north of Morgan City, Louisiana (station 337).

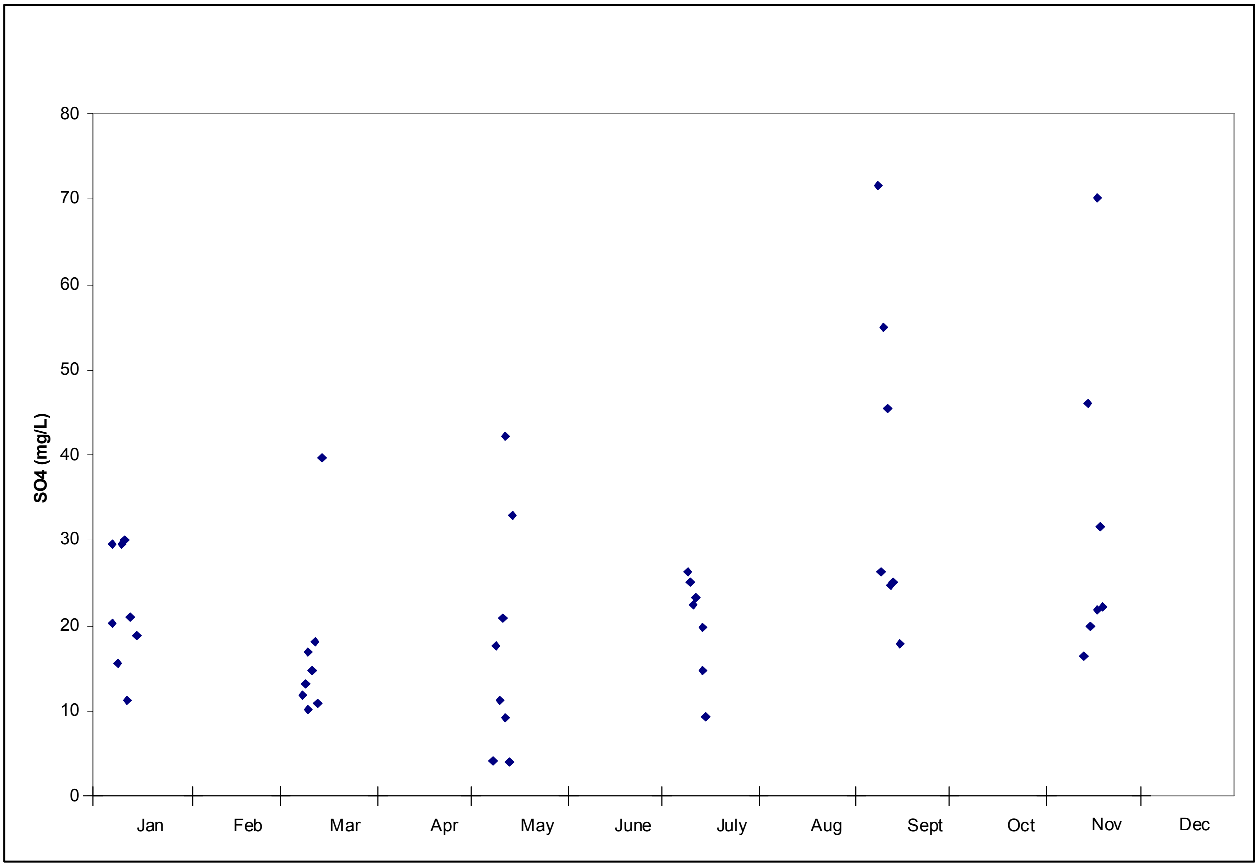

Figure E-4. Seasonal sulfate observations at Belle River (subsegment 120201) north of Morgan City, Louisiana (station 337).

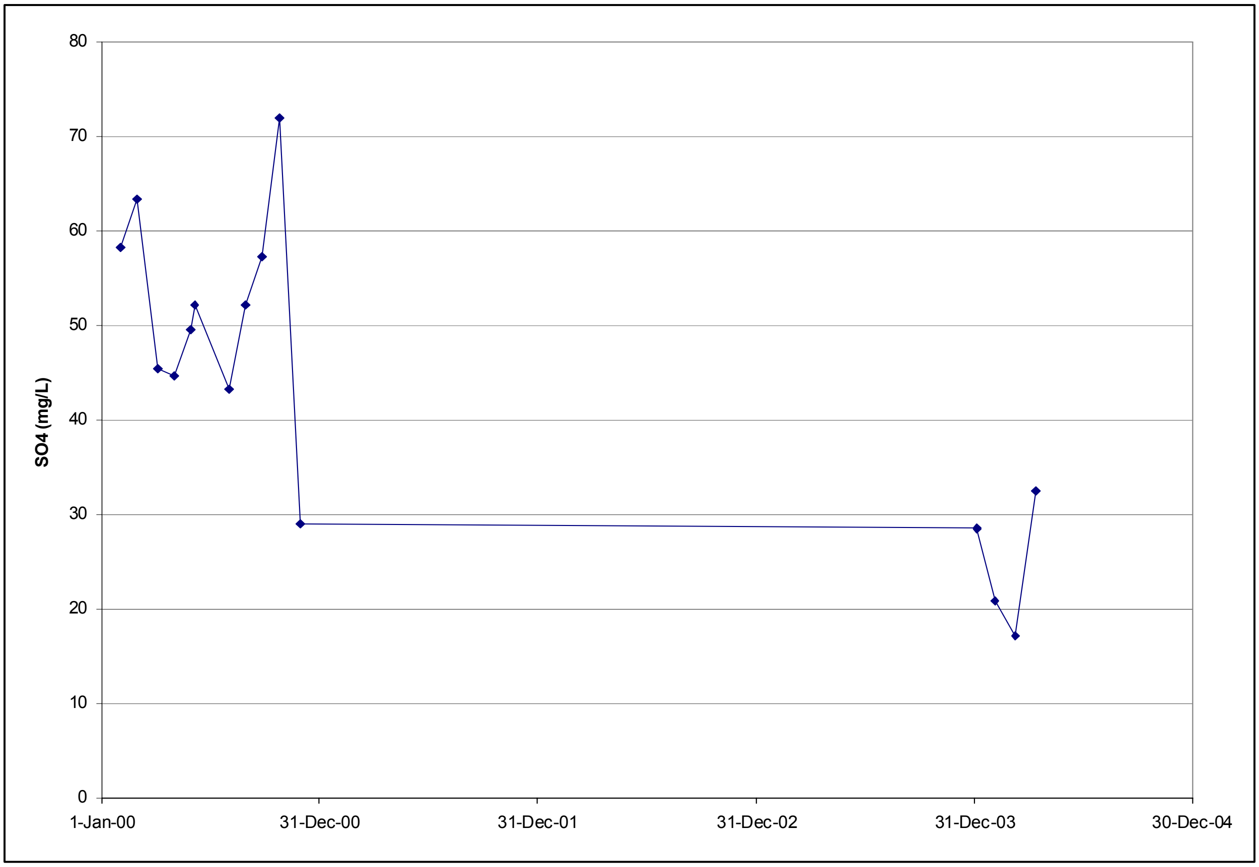

Figure E-5. Sulfate observations at Lower Grand River (subsegment 120201), Louisiana (station 979).

Appendix F
Total Dissolved Solids Figures for the Terrebonne River Basin

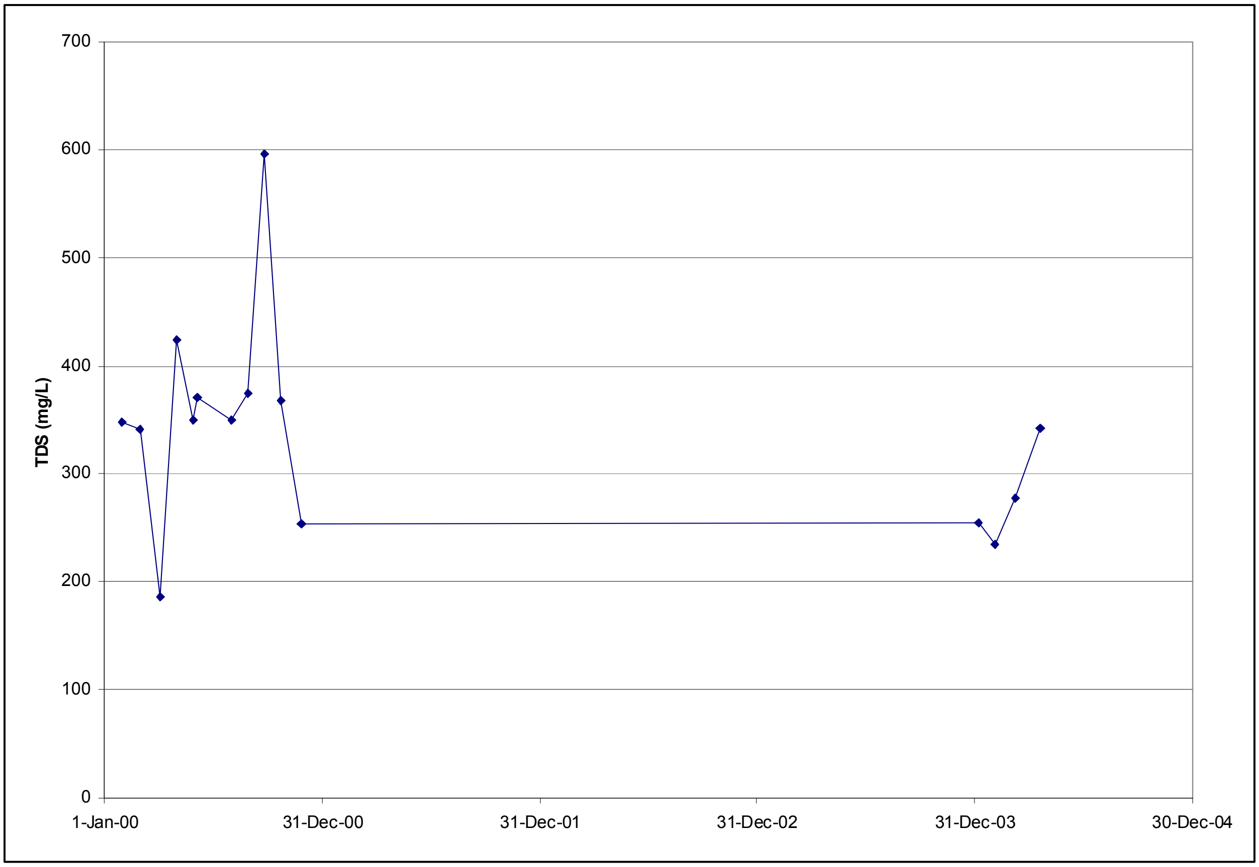

Figure F-1. TDS observations at Bayou Portage (subsegment 120101), Louisiana (station 968).

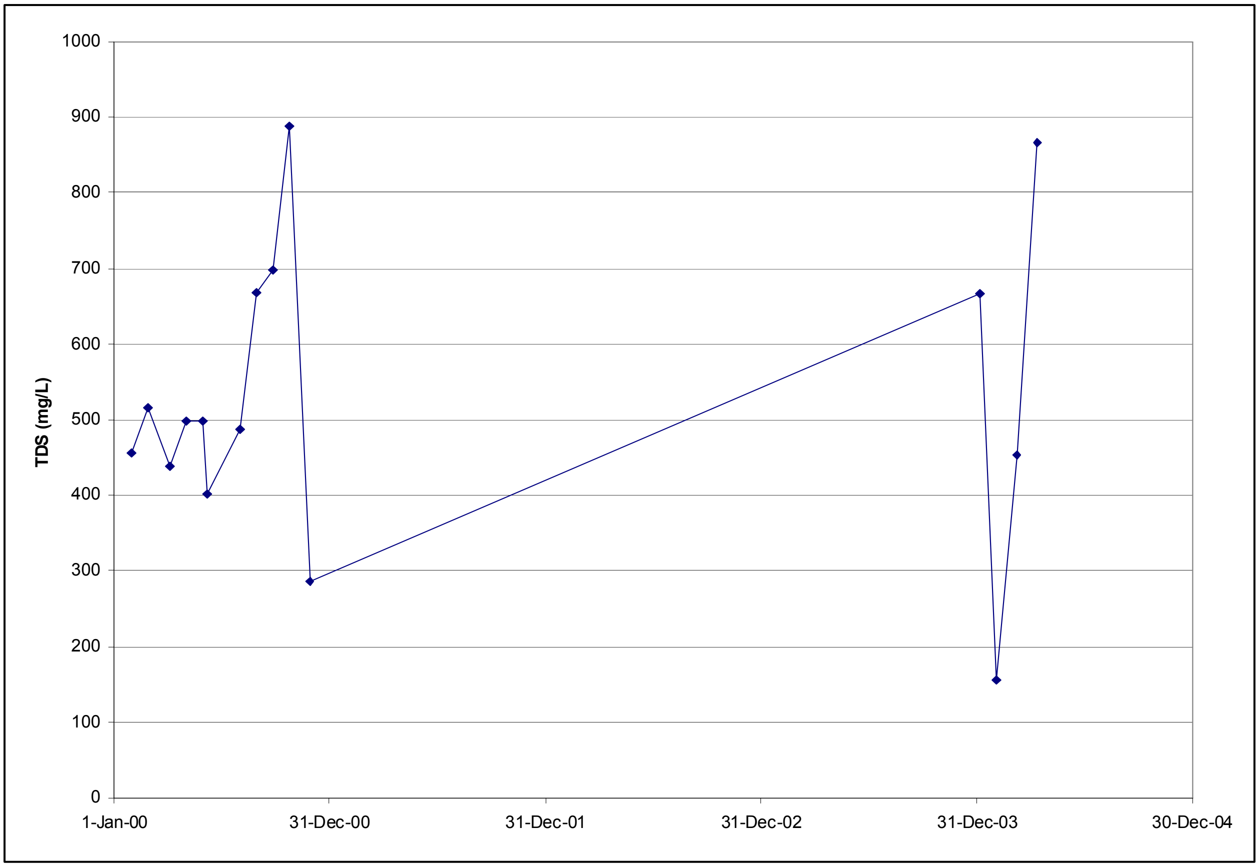

Figure F-2. TDS observations at Bayou Poydras (subsegment 120102), Louisiana (station 969).

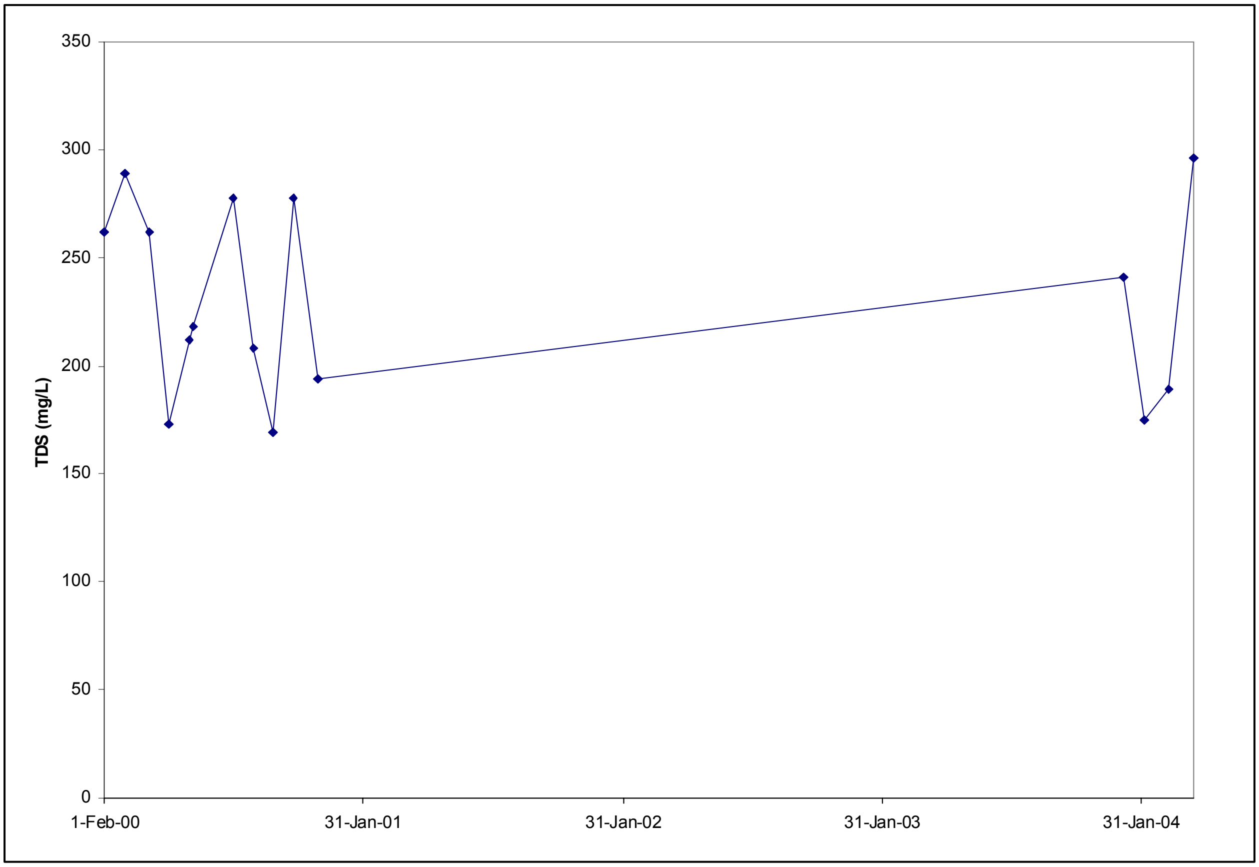

Figure F-3. TDS observations at Bayou Grosse Tete (subsegment 120104), Louisiana (station 970).

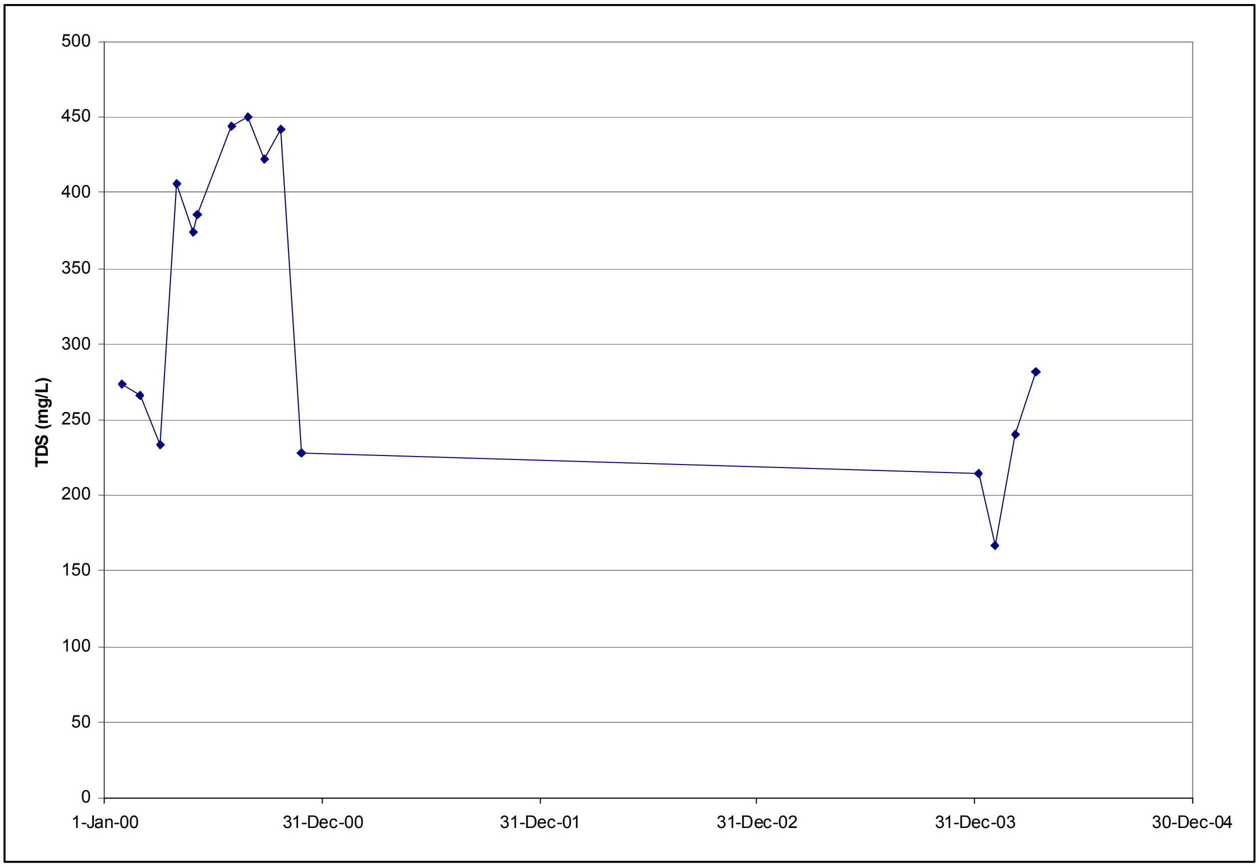

Figure F-4. TDS observations at Bayou Chalpin (subsegment 120110), Louisiana (station 976).

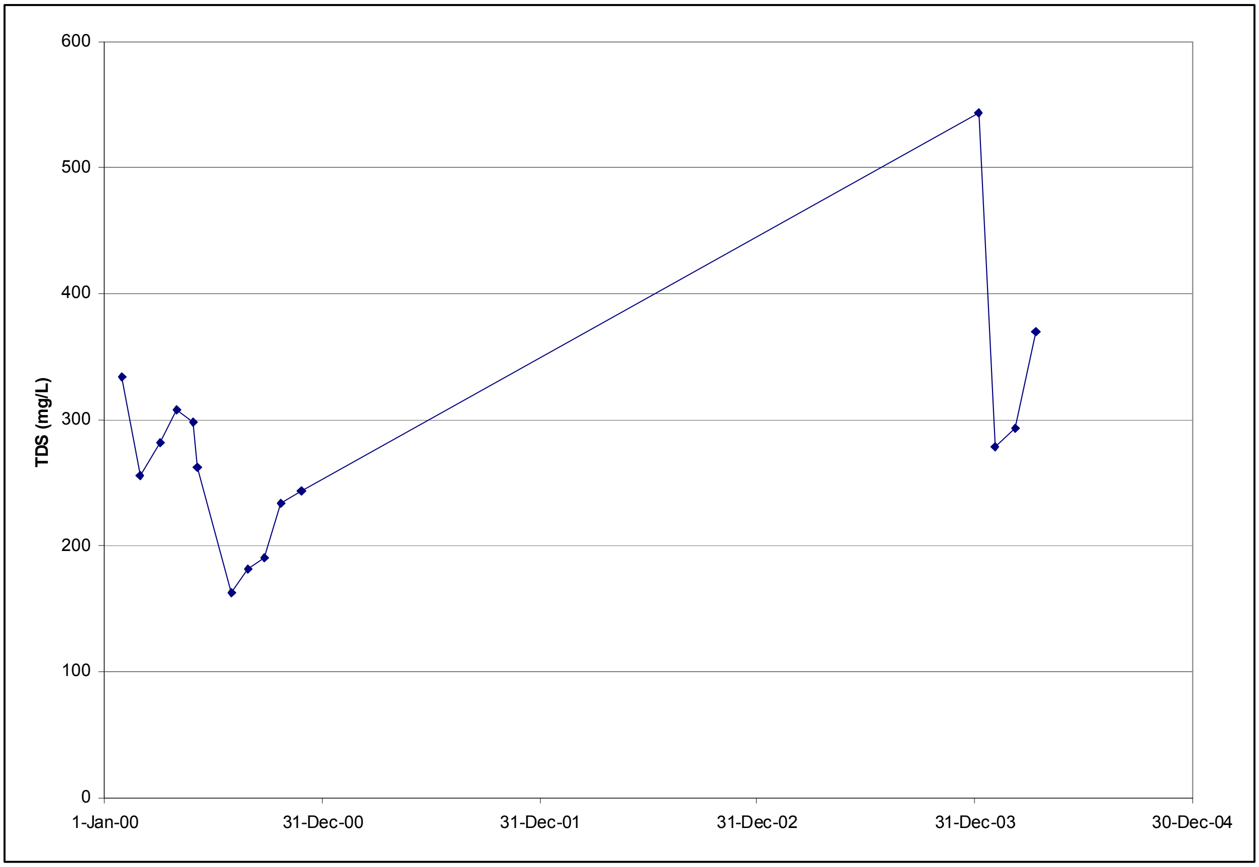

Figure F-5. TDS observations at Bayou Maringouin (subsegment 120111), Louisiana (station 977).

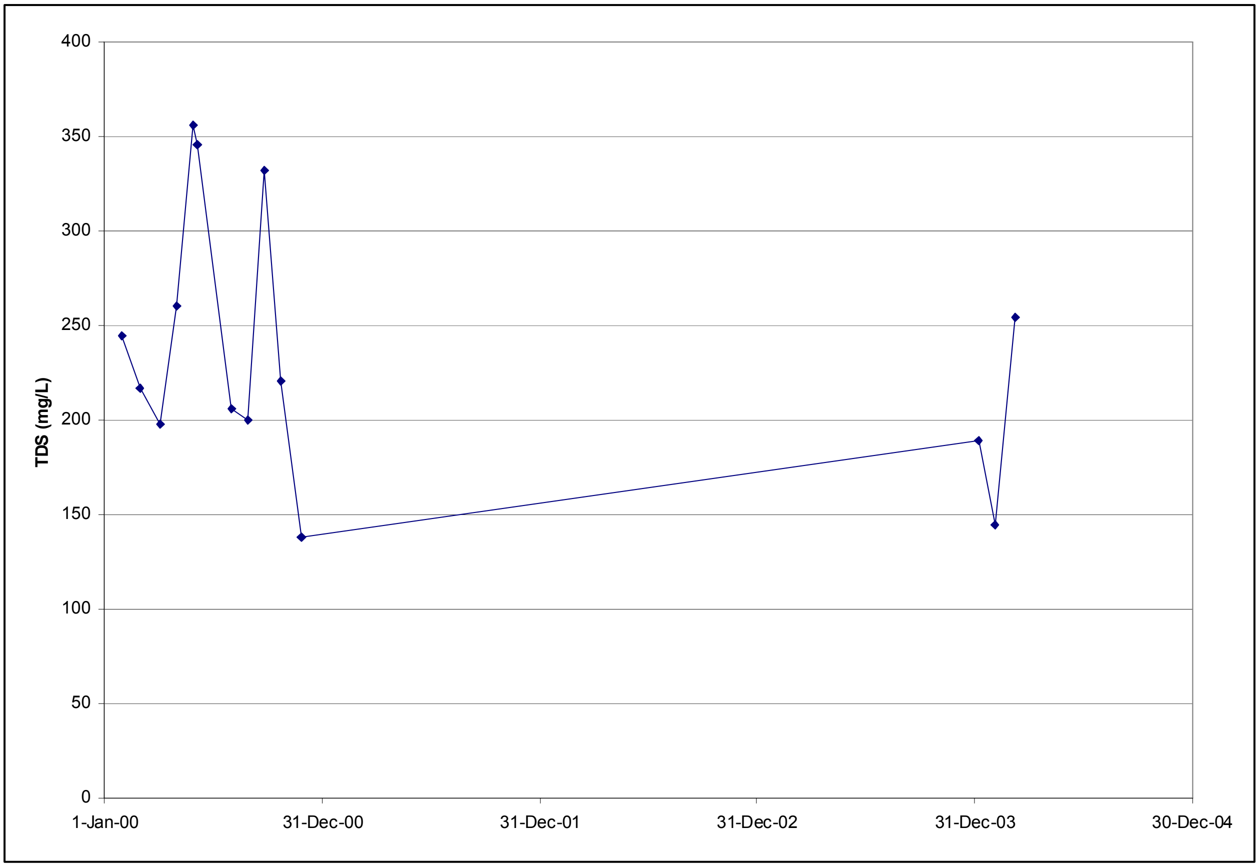

Figure F-6. TDS observations at Bayou Fordoche (subsegment 120112), Louisiana (station 978).

Appendix F
Total Dissolved Solids Figures for the Terrebonne River Basin

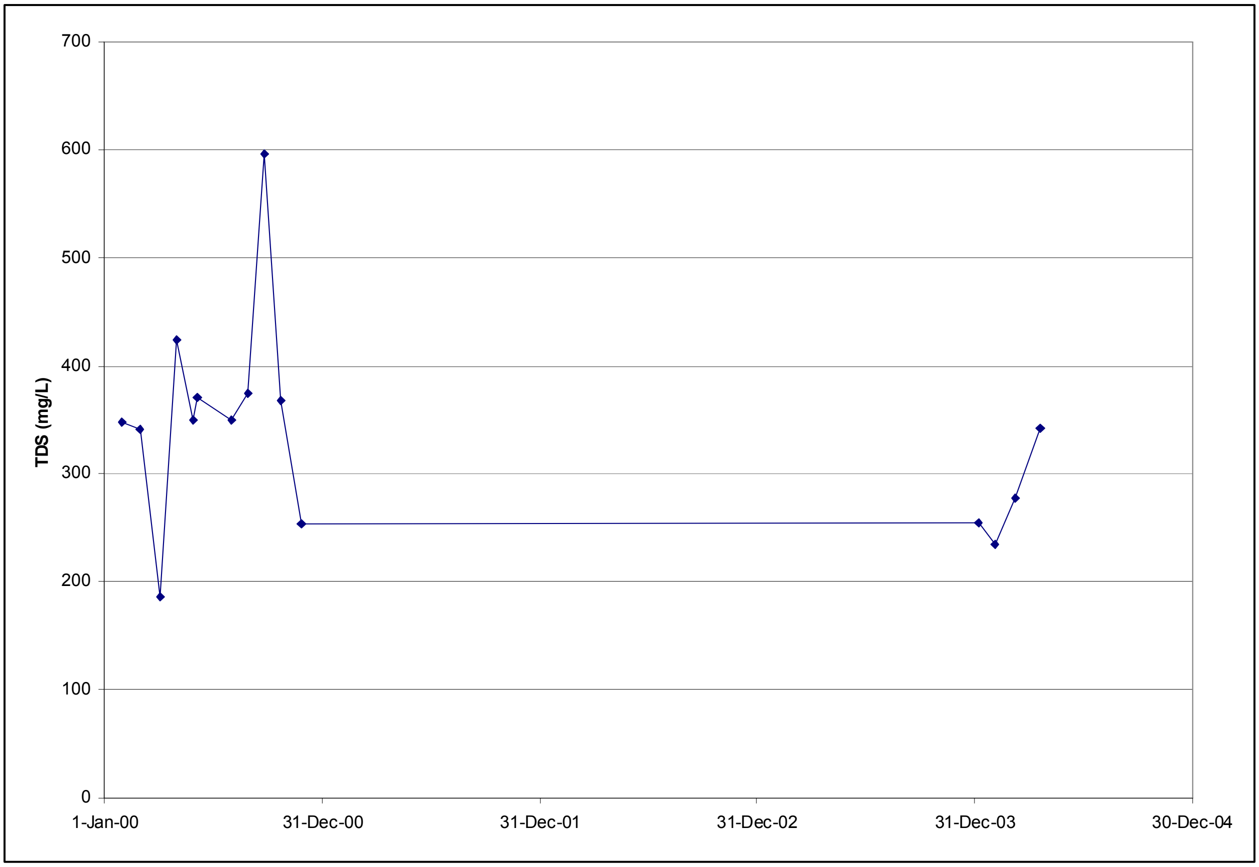

Figure F-1. TDS observations at Bayou Portage (subsegment 120101), Louisiana (station 968).

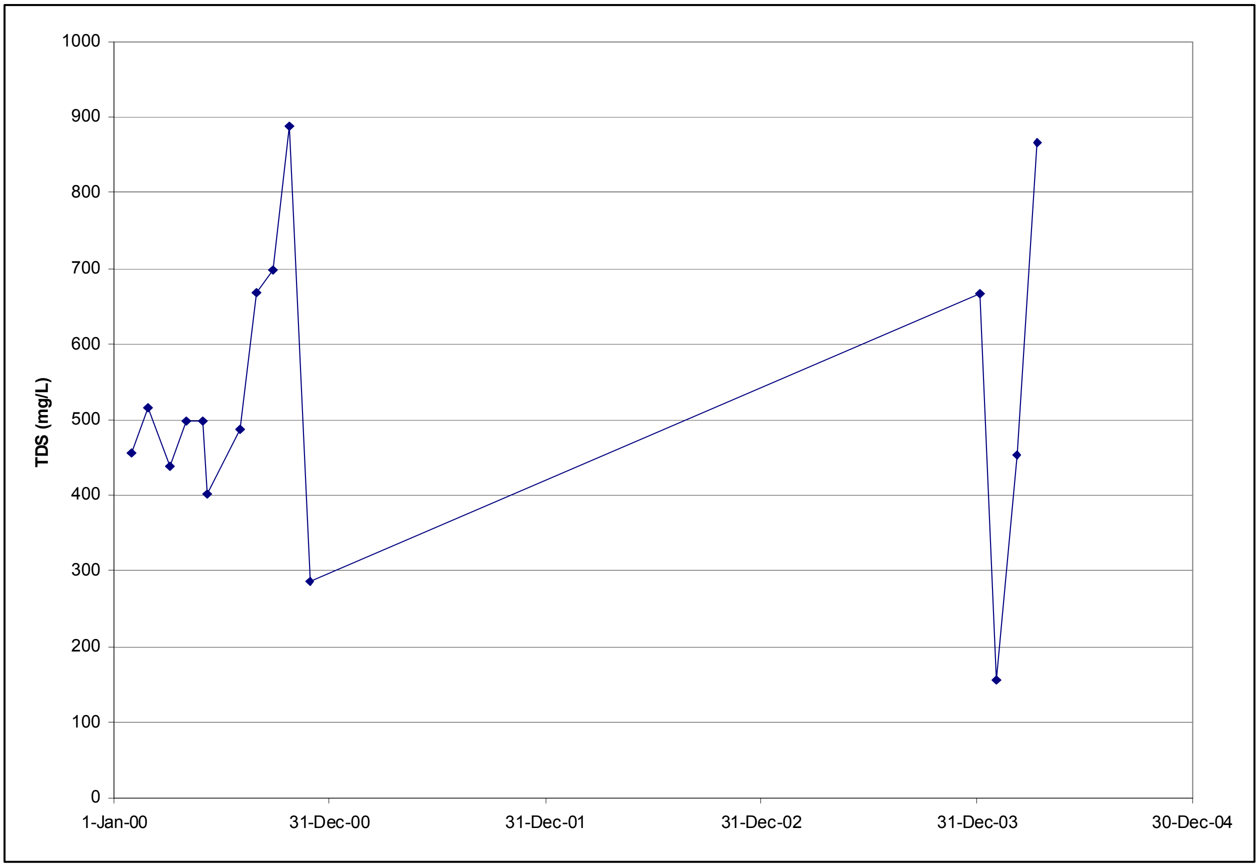

Figure F-2. TDS observations at Bayou Poydras (subsegment 120102), Louisiana (station 969).

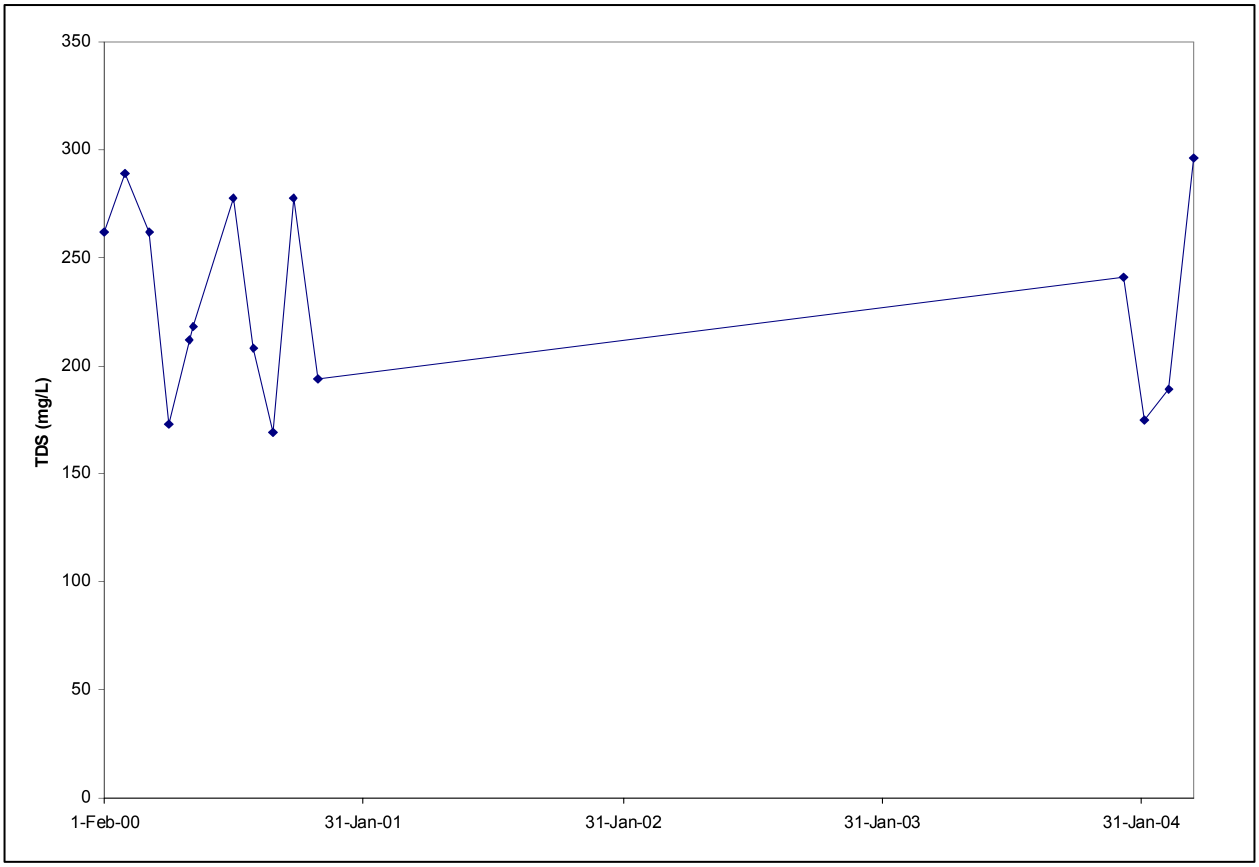

Figure F-3. TDS observations at Bayou Grosse Tete (subsegment 120104), Louisiana (station 970).

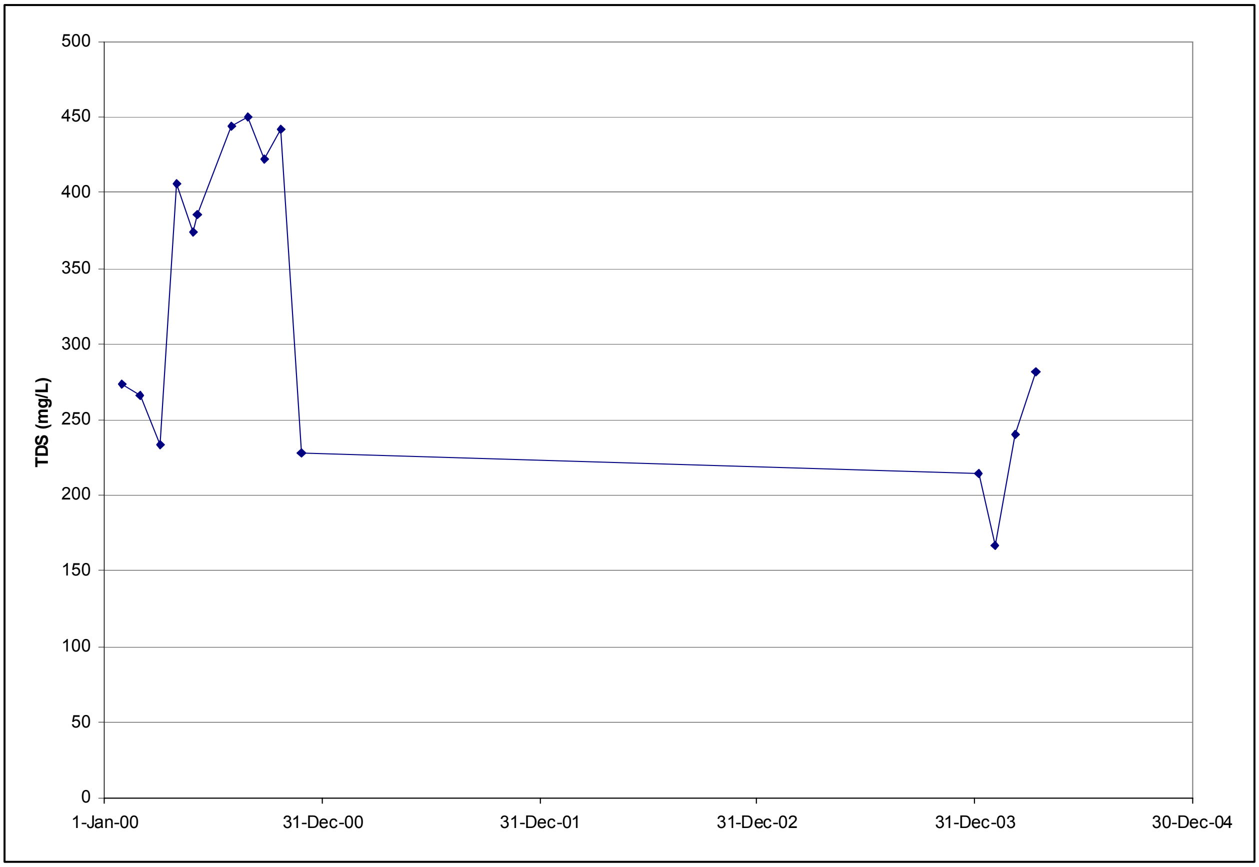

Figure F-4. TDS observations at Bayou Chalpin (subsegment 120110), Louisiana (station 976).

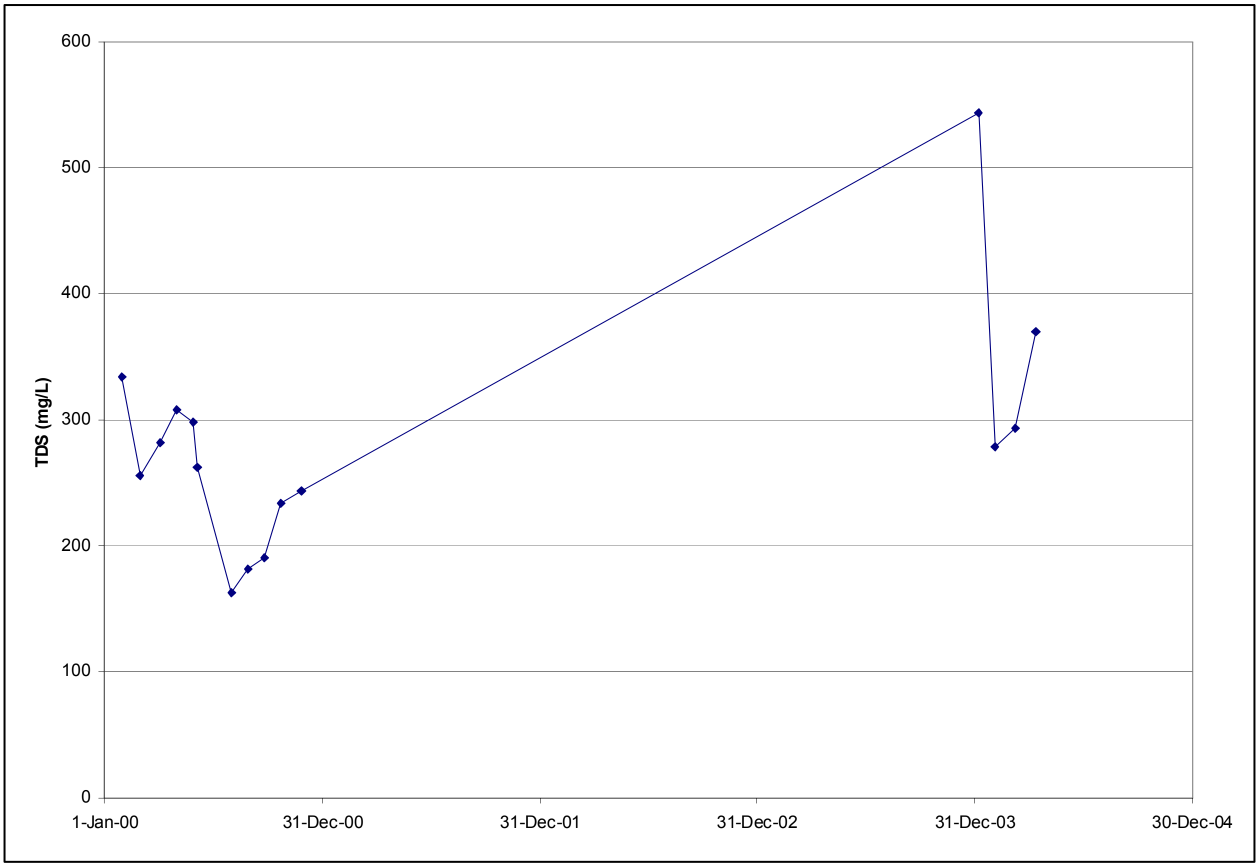

Figure F-5. TDS observations at Bayou Maringouin (subsegment 120111), Louisiana (station 977).

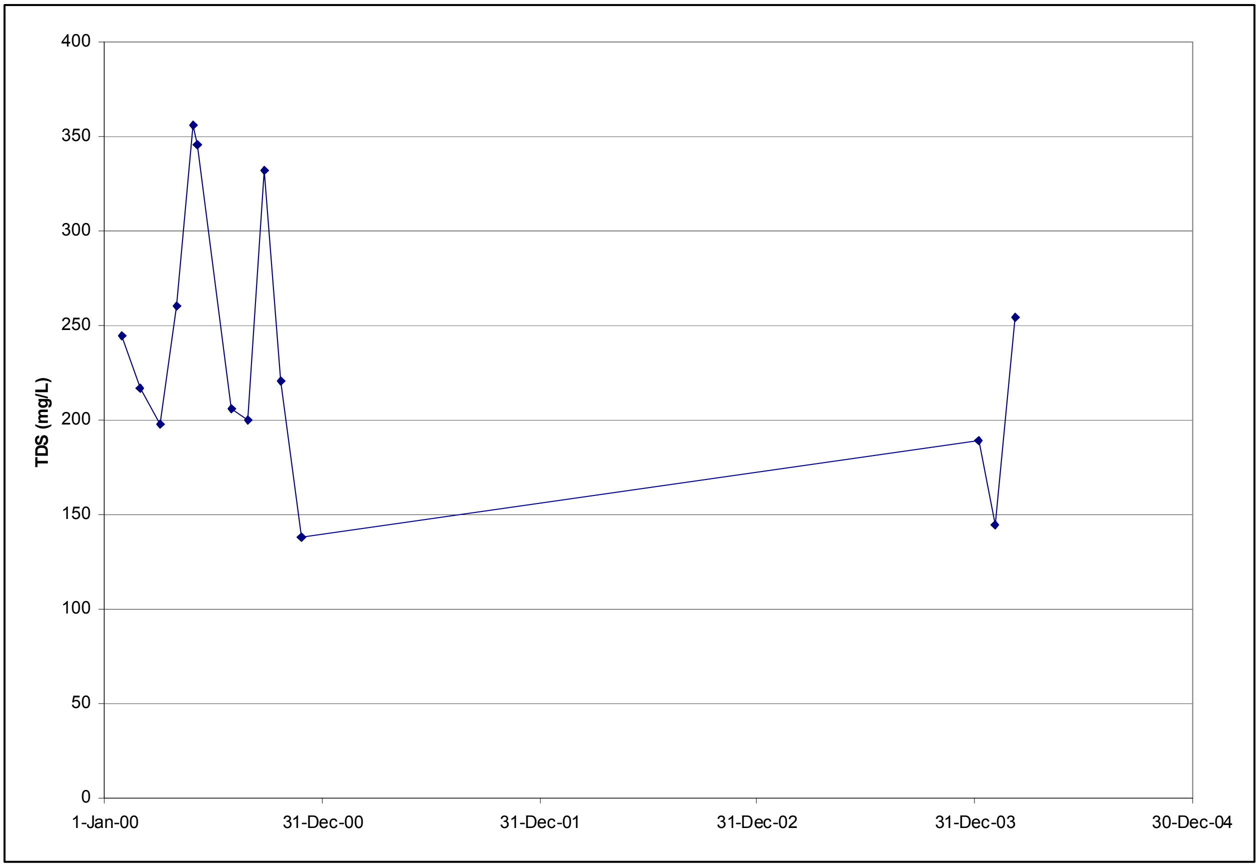

Figure F-6. TDS observations at Bayou Fordoche (subsegment 120112), Louisiana (station 978).

Appendix G
Turbidity Figures for Terrebonne River Basin

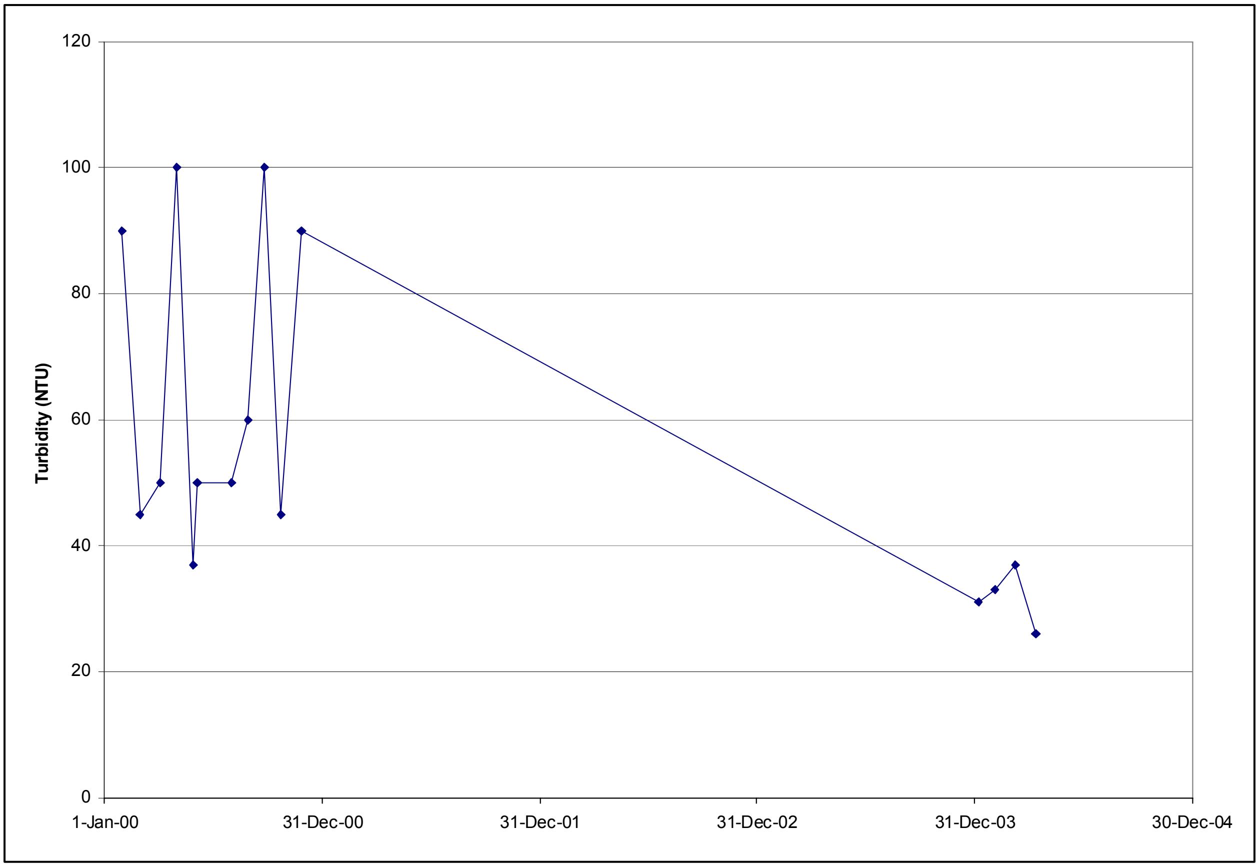

Figure G-1. Turbidity observations at Bayou Plaquemine (subsegment 120106), Louisiana (station 972).

Appendix H
TSS Figures for Terrebonne River Basin

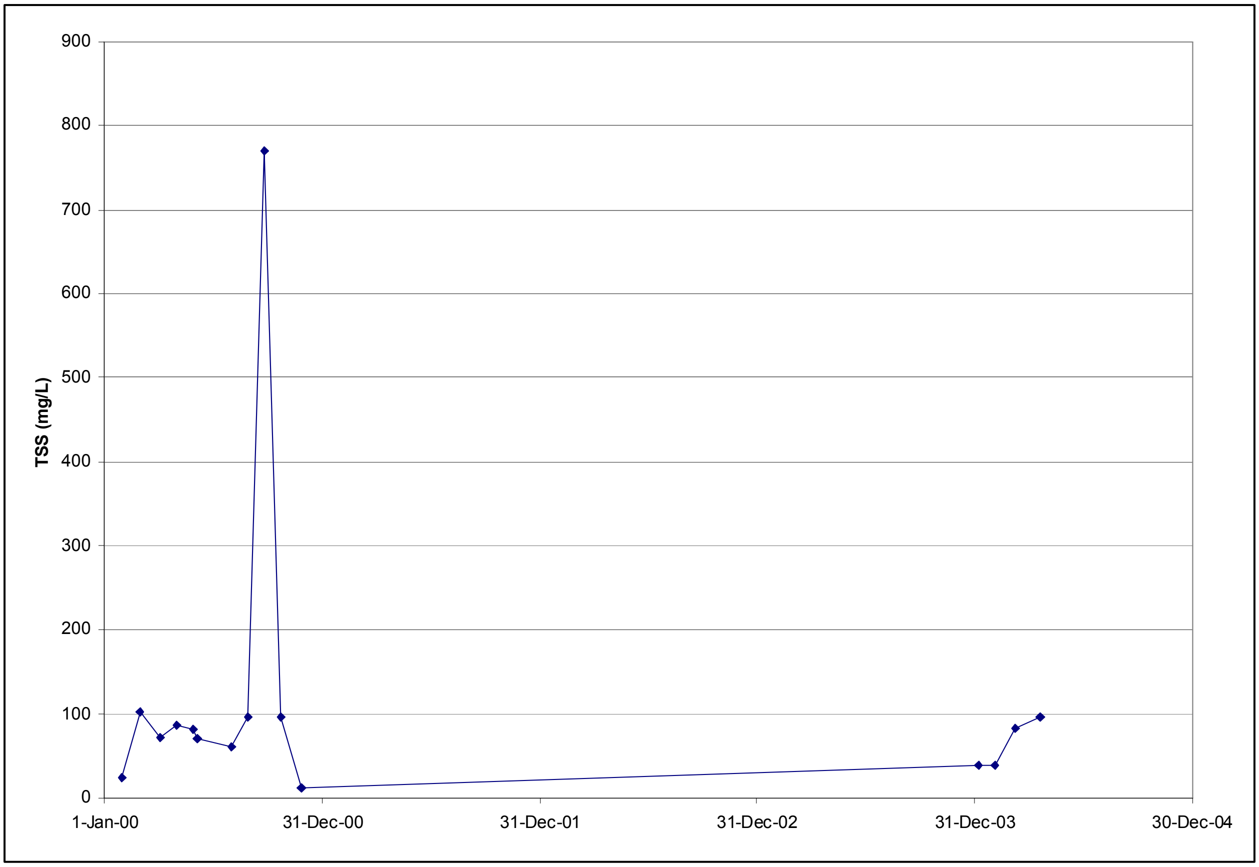

Figure H-1. TSS observations at Bayou Portage (subsegment 120101), Louisiana (station 968).

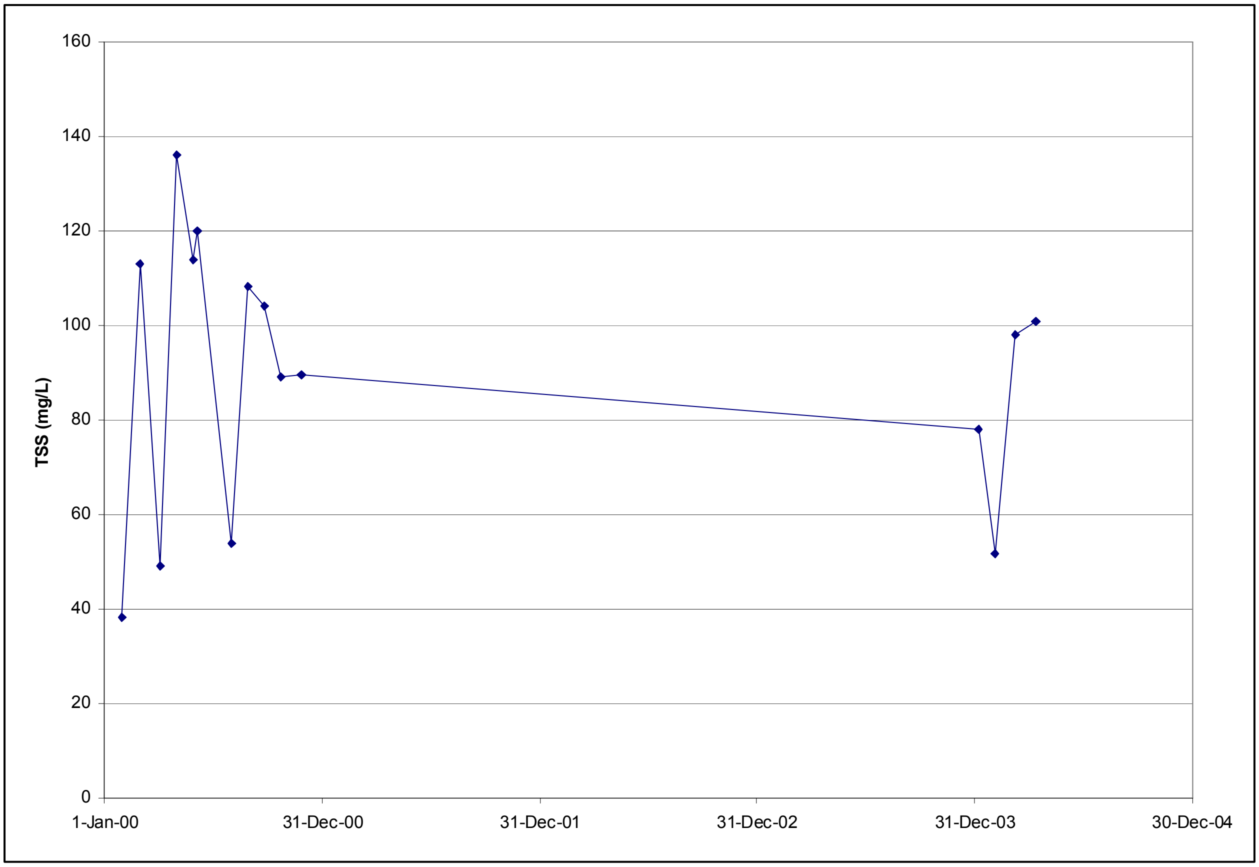

Figure H-2. TSS observations at Bayou Poydras (subsegment 120102), Louisiana (station 969).

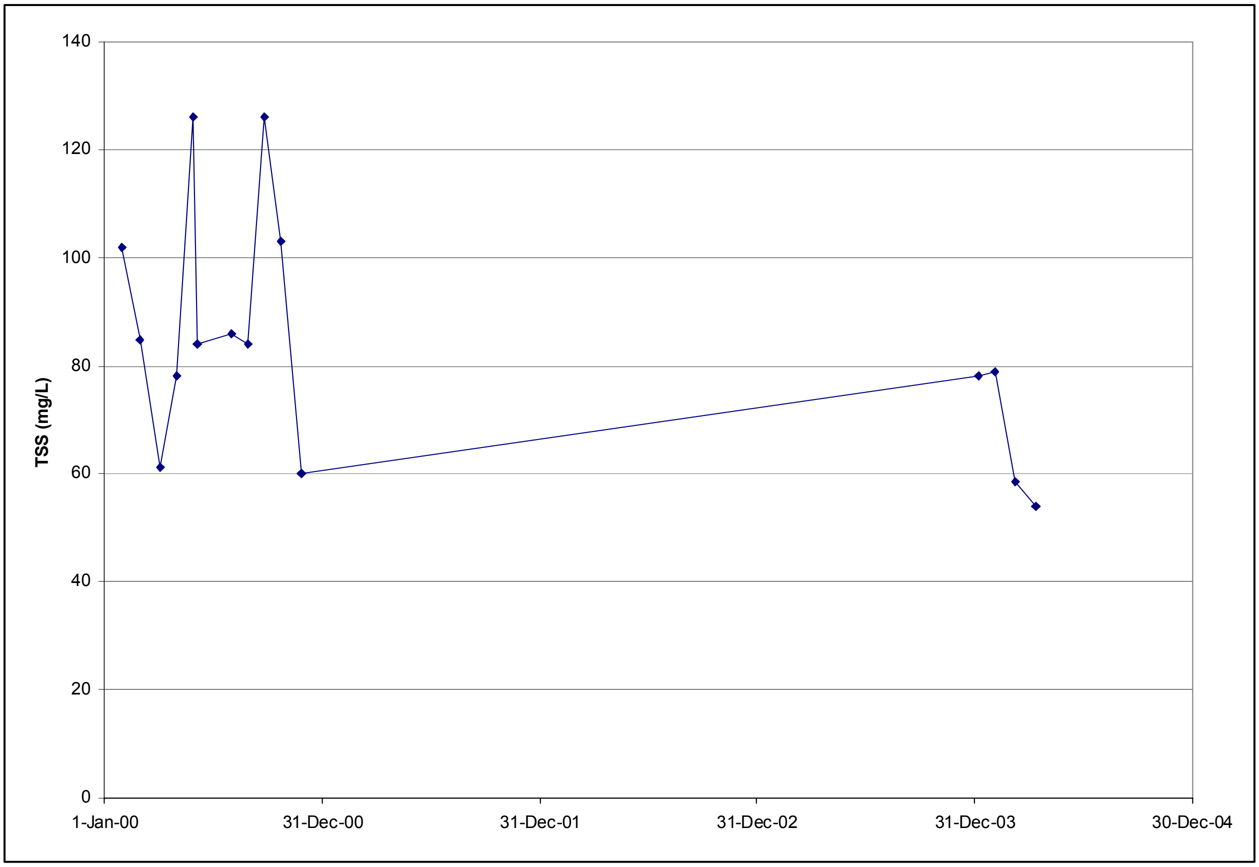

Figure H-3. TSS observations at Chamberlin Canal (subsegment 120105), Louisiana (station 971).

Appendix J
TSS Versus Turbidity Figures for Terrebonne River Basin

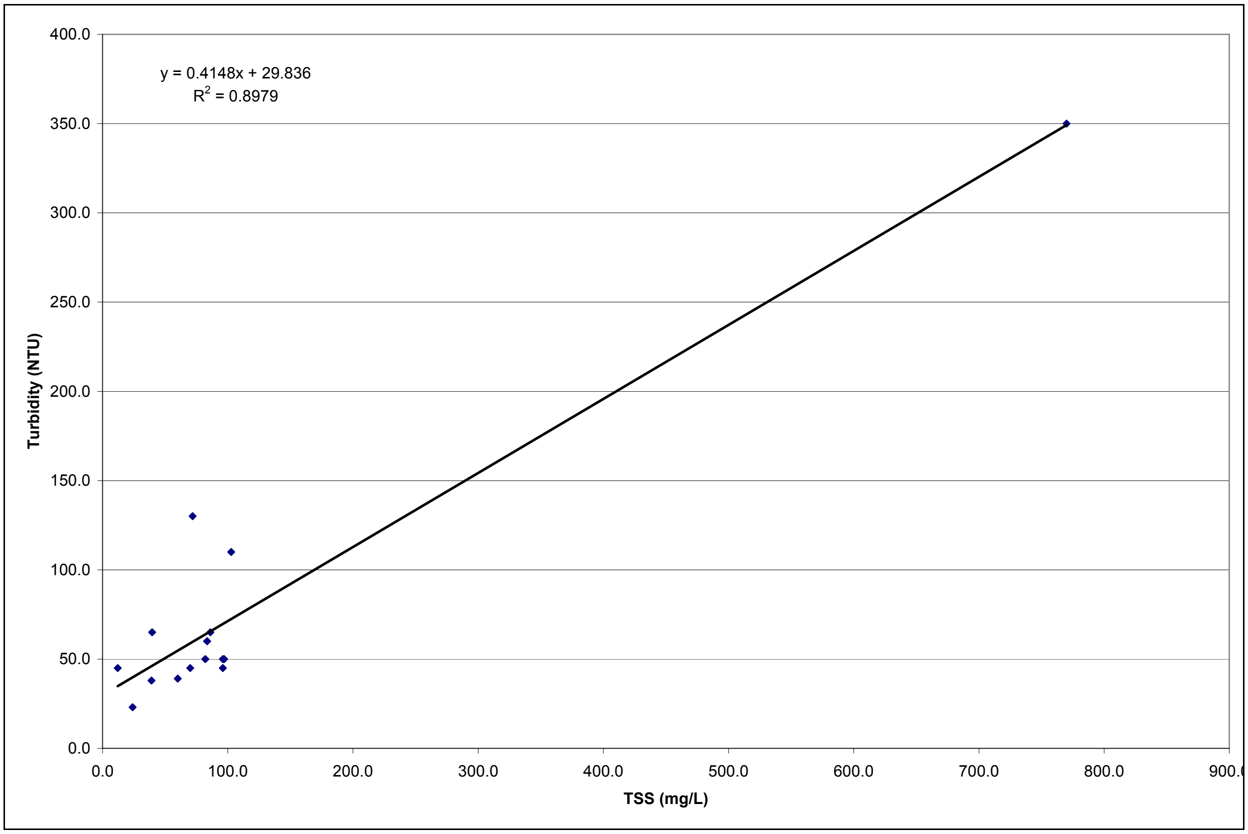

Figure J-1. Turbidity versus TSS at Bayou Portage (subsegment 120101), Louisiana (station 968).

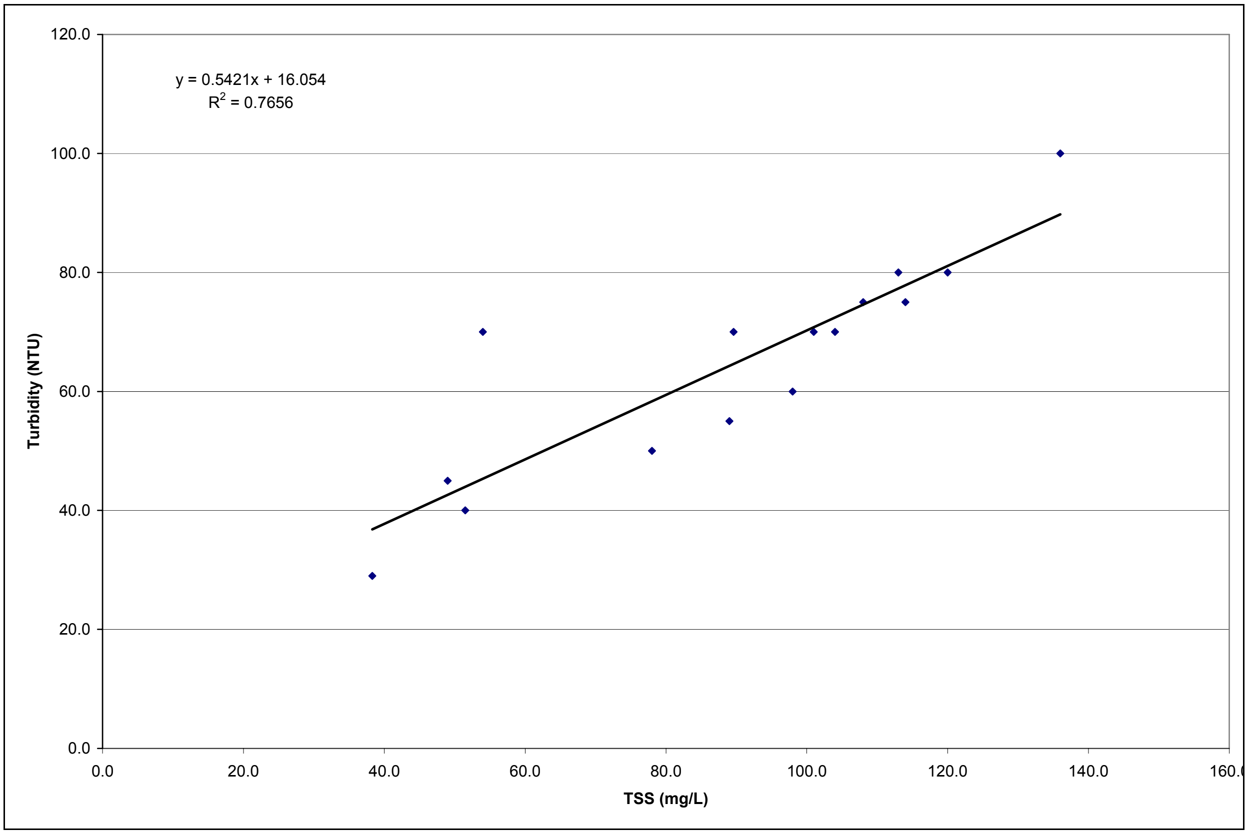

Figure J-2. Turbidity versus TSS at Bayou Poydras (subsegment 120102), Louisiana (station 969).

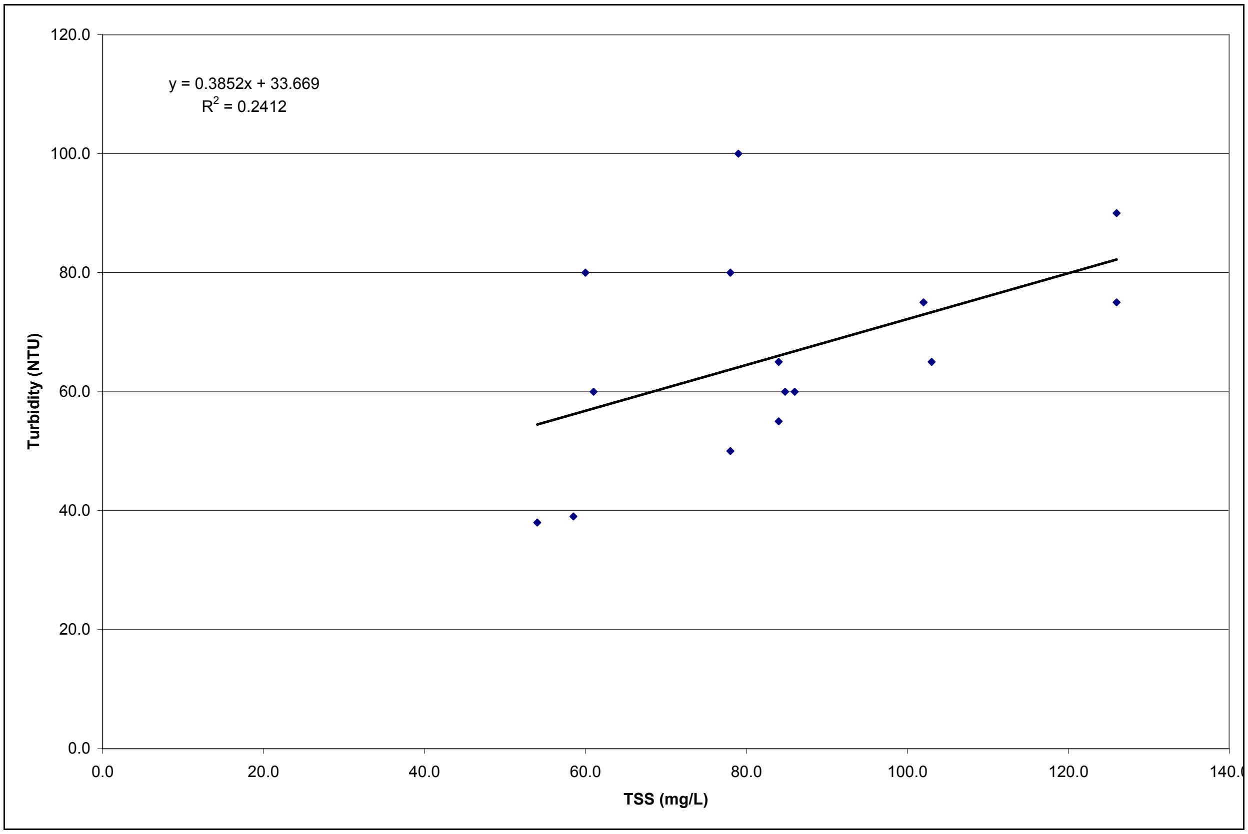

Figure J-3. Turbidity versus TSS at Chamberlin Canal (subsegment 120105), Louisiana (station 971).

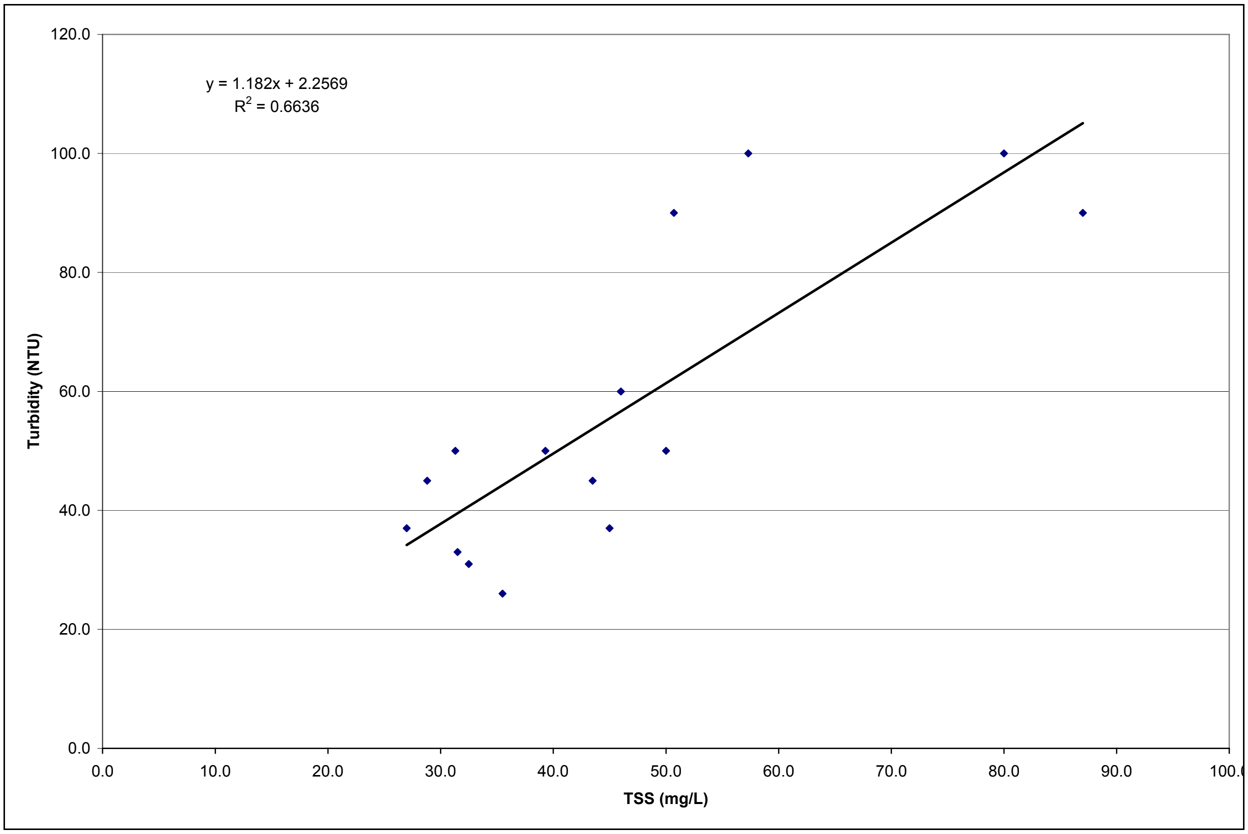

Figure J-4. Turbidity versus TSS at Bayou Plaquemine (subsegment 120106), Louisiana (station 972).